RED SEA POLYCHAETES FROM THE GULF OF ELAT (AQABA)

A contribution to the knowledge of the Polychaeta fauna and the environmental conditions which affect its distribution

by

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FOREWORD

The work presented in this thesis is original, except where otherwise stated and acknowledged in the text. All the topics underlined in the following ABSTRACT indicate a contribution to knowledge, the possible exception being the laboratory technique of handling minute specimens which might be practised by some colleagues elsewhere. However, no such workable technique was known to the author, and its development was a prerequisite for the systematic part of the thesis.

ABSTRACT

A study of 50 samples of Polychaeta mainly from a northern profile (0.5 - 550 m) and down to 800 m, reveals that the fauna is characterised by extremely small specimens and a great taxonomic divergence. Techniques of handling minute specimens are described, together with 21 new species, including three subspecies, six new genera and a new subgenus. The discovery of aberrant genera indicates a substantial endemism, the evolution of which is enabled by: (a) the narrow Straits of Tiran which separates the Gulf from the Red Sea proper; (b) the hydrographical factors causing vertical homogeneity of temperature, salinity and oxygen, as well as (c) a possible zone of convergence which isolates the Gulf's northern part to an as yet unknown degree. The pattern of family distribution and specimen frequencies confirms the existence of six successive benthic associations along an analysed sediment profile. The poor biomass of the fauna indicates that the Gulf has an overall low productivity, caused by the limited amount of fresh water run-off, low content of organic matter and small quantities of nutrients.

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SUPPORTING PAPERS:

1. A contribution to the revision of Spiochaetopterus (Chaetopteridae, Polychaeta), Sarsia 37 : 9-20, 1970.

2. A review of Augeneriella (Polychaeta: Sabellida) and a new species from northern Sinai, Israel J. Zool. 19 (2) : 105-109, 1970.

3. Marine farming prospects on the South African west coast, S.Afr. Shipp. news Fish. Ind. Rev. 27 (5) : 50-53, 1972.

INTRODUCTION

The Gulf of Elat (Aqaba), at the northern end of the Red Sea, is noted for its depth, which exceeds 1800 m, in comparison with the neighbouring Gulf of Suez which only reaches about 65 m. Unlike the fauna of the littoral elsewhere, the benthic fauna of the Gulf of Elat is poorly known (Por and Lerner-Seggev, 1966). This is also true of the deeper parts of the Red Sea where some of the southern basins are considered to be abiotic (Sewell, 1935; Oren, 1962a).

Polychaetes of the Gulf of Elat, so far only known from shallow waters (1-100 m), were described by Fauvel (1957, 1958) and by Fishelson and Rullier (1969). Records of Red Sea polychaetes from deep water (below 100 m) are very limited (Fishelson and Rullier, 1969) in contrast with the ample knowledge of littoral and shallow water species.

In addition to the authors already mentioned, other contributions to the knowledge of the Red Sea polychaetes have been made by Savigny (1820), Grube (1868, 1870), Gravier (1899, 1900, 1902, 1904, 1905, 1906, 1906a, 1908), Fauvel (1918, 1919, 1927a, 1933, 1951, 1955), Crossland (1924), Hartmann-Schröder (1960), Storch (1966, 1967, 1967a, 1967b) and Day (1957).

The three last-mentioned authors described a high proportion of new species from collections not fully

representative. This may indicate that even the knowledge of the shallow water fauna is far from complete. Therefore, one may expect that a study which deals with deep water fauna will yield a great number of new species. Even more so if minute specimens, which are plentiful in the natural environment, are not ignored.

That small specimens composed a great proportion of the polychaete fauna was demonstrated by Hartmann-Schröder (1960). Examination of dredge samples by the author while aboard research vessels have indicated that the same applies to the fauna of Norwegian and South African waters.

The minute specimens include those fractions of the fauna with a size below 4 mm in length or 0.3 mm in width. The scarcity of these fractions in most works may be ascribed to two factors. Firstly, the sieves used to separate the samples often had a mesh size large enough to allow the small specimens to pass through, and second, the discouraging difficulties of handling such small specimens led to their being very often discarded.

These difficulties may start right at the sorting-out stage, when even the slightest degree of over-handling often causes the loss of tentacles and other appendages, whose presence is indispensible for correct identification. In a good many cases the whole specimen has to be mounted for compound microscope examination, in order to separate the specimens just to the elementary family level. For

identification to the species level, oil immersion lenses must be used, not only for the usual study of setae, but also for examination of the whole mount. This however could be a time consuming technique, since it requires that the coverslip be sealed if the animal underneath is to be preserved for further examination.

Other problems encountered in this study were the geographical isolation of Cape Town, which not only prevented access to most type species, but also to the better equipped Western libraries where old but fundamental literary references are available. Since these obstacles prevented a satisfactory identification of many specimens, only new or controversial species are described in the chapter on taxonomy.

MATERIALS AND METHODS

Most of the material, together with 13 samples of sediments, was collected from the Gulf of Elat on a profile down to 550 m along the centre of the northern tip. Other polychaete samples were taken randomly along the western side of the gulf as far as the southern end of the Sinai peninsula. Altogether 50 samples of fauna were collected, the principal locations of which are shown in Figure 1.

The sampling equipment used was an Emery-type bottom grab of 0.05 m^2 and sometimes an Ockelman sledge, a Menzies trawl and a rock dredge. Samples from waters shallower than 5 m were mostly collected with a hand net while diving. The same net, with a mesh size of 250 μ, was used for sieving all samples.

The majority of the samples were treated live, with a seawater solution of 4% $MgSO_4$, to cause an eversion of the pharynx. In some cases, samples were treated with Rose Bengal dye in order to facilitate easier observation of other benthic groups, although this proved of little benefit in the identification of the polychaetes. All material was fixed in 4% neutral (Hexamine) formalin and later transferred to 70% alcohol.

Due to the fact that a great proportion of the material was small, these specimens had to be mounted for compound microscope examination. For this purpose the most effective

method was to employ cavity slides of 1 mm depth. This depth enabled a magnification of x40 to be used, even without a coverslip, when the mounting medium was lactophenol. The transfer from alcohol to lactophenol was through descending concentrations of alcohol (Brinkhurst, 1963). This is necessary, as a direct transfer would decompose the lactophenol.

The advantages of lactophenol are:

a) it eliminates the problem of mountant evaporation;

b) specimens can be kept in it for at least five years, and probably on a permanent basis;

c) it is a good clearing agent, especially when hot, and finally

d) the animals can be transferred directly to a permanent mount in either polyvinyl lactophenol or in lactophenol alone, sealed with Gurr's Glyceel.

Permanent slides of polyvinyl lactophenol dry up within a fortnight and tend to clear all the soft tissues, which is an advantage in the study of the chitinous parts of Annelids. On the other hand, if the soft parts must be visible, polyvinyl lactophenol is unsuitable. For ordinary whole mount preparation the combination of lactophenol and Glyceel was found to be the most suitable one. Gurr's Glyceel dries within 24 hours, it can be trimmed or removed with a sharp blade if necessary and is unaffected by alcohol, so that coverslips can be cleaned of immersion oil with ease.

As it was found to be an advantage to study whole mounts from both sides, an histological technique was followed whereby a specimen could be sealed between two thin coverslips. One coverslip 25 x 22 mm is placed on a micro-slide and the specimen is mounted below a round coverslip which has a diameter of 18 mm. After sealing the round coverslip, the animal can be studied from either side with any type of lens. The micro-slide is used only as a supporting base to which the whole mount is attached with tape. Apart from being very convenient, the above mentioned methods considerably reduce the need to touch fragile specimens and thus were found to be most useful in the study of minute specimens.

When specimens were separated into families, the frequency of occurrence of specimens from each family was noted and a code number assigned (Table I). These data provide an indication of the relative distribution of the polychaetes along the main profile and are discussed in the chapter dealing with the main benthic associations.

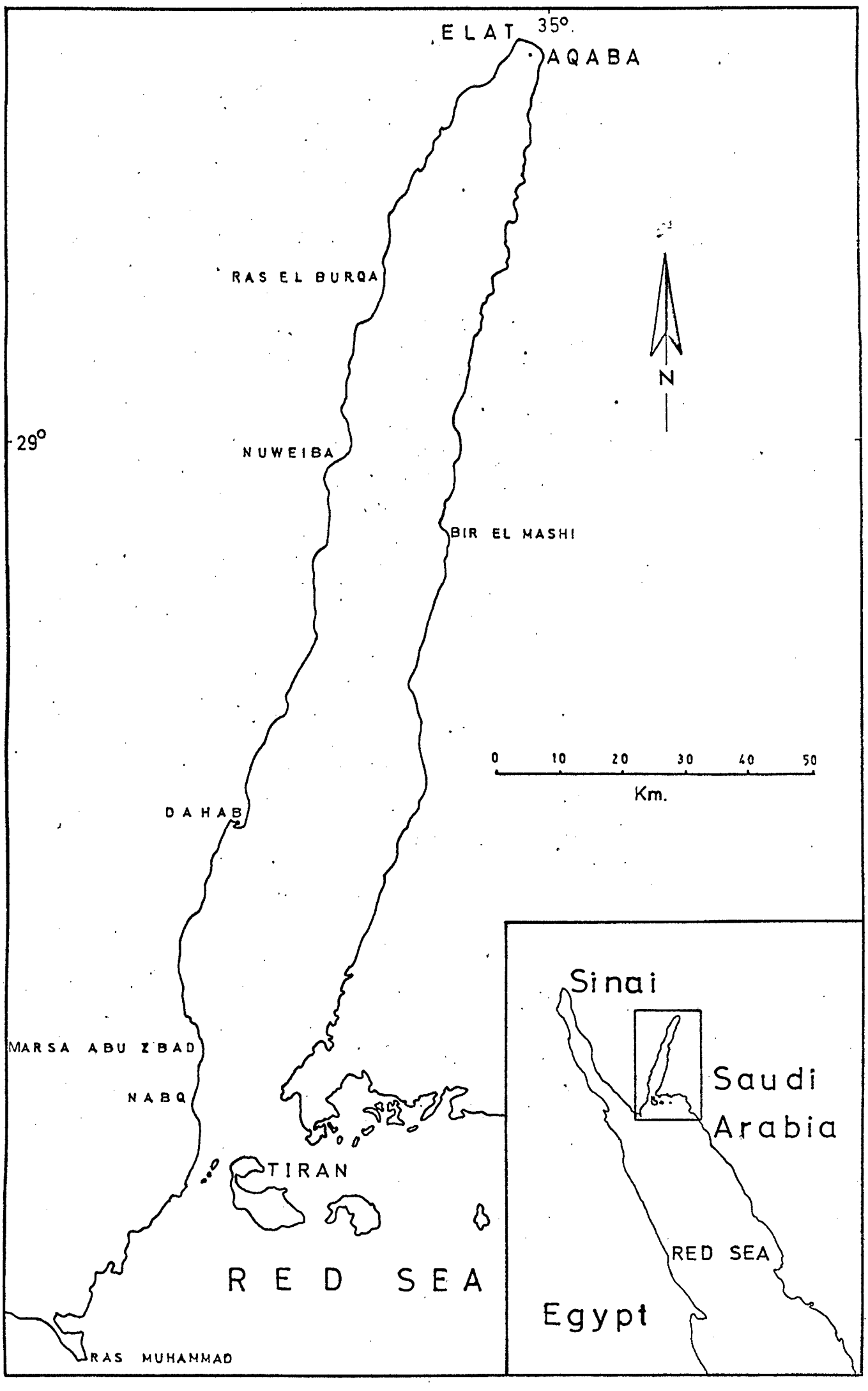
The sediments all along the ecology profile were analysed with the Pipette method (Krumbein and Pettijohn, 1938) and Shepard's sediment terminology (Shepard and Moore, 1954) is used in the text where appropriate.

TABLE I

FREQUENCY OF SPECIMEN ABUNDANCE

Code No.	Abundance	Number of specimens
1	present	1 - 4
2	fairly common	5 - 10
3	common	11 - 25
4	very common	25 - 40
5	abundant	> 40

FIGURE 1: Gulf of Elat with the location of the principal collecting stations.


ELAT
35°
AQABA
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BIR EL MASHI
0 10 20 30 40 50
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MARSA ABU ZBAD
NABQ
TIRAN
RED SEA
RAS MUHAMMAD
Sinai
Saudi
Arabia
RED SEA
Egypt

SYSTEMATIC ACCOUNT

SYLLIDAE Grube

Exogoninae Rioja

Exogone Oersted, 1845

Exogone dispar (Webster, 1879)

Paedophylax dispar Webster, 1879 : 223, fig. 49-55.

Exogone clavator Ehlers, 1913 : 485, pl. 33 fig. 1-6; Day, 1953 : 418, fig. 4 d-f; Hartmann-Schröder, 1960 : 106; Day, 1967 : 272, fig. 12.10.a-f.

Exogone dispar: Hartman, 1945 : 16, pl. 2 fig. 7, 9, 10; Pettibone, 1963 : 130, fig. 35d; Day (in press).

1st Red Sea variety

(fig. 2 A-D)

R e c o r d s : Elat, 7 m (1 specimen) - 16.2.1967; 10 m (1) - 13.7.67; Nabq, 0.5 m (2) - 11.5.68; Marsa Abu Zbad, 60 m (1) - 26.9.67; Ras Muhammad, 1.5 m (3); 2 m (5) - 18.9.67.

R e m a r k s : This variety is distinguished by its simple setae. The tip of the superior one (fig. 2 A) is encircled with small teeth while the simple inferior seta (fig. 2 B) is toothed on its convex edge. The corresponding setae in E. dispar (Webster, 1879, fig. 54, 55) are

superiorly smooth and inferiorly bifid. Like E. dispar and E. clavator, this Red Sea variety contains falcigerous setae (fig. 2 C) with a bifid blade as described by Hartman (1949, pl. 2, fig. 10) and has spinigerous setae (fig. 2 D) which commence on setiger 1.

South African variety

(fig. 2 E)

M a t e r i a l e x a m i n e d : 2 specimens in the collection of the University of Cape Town - KNY. 199B.

R e m a r k s : E. clavator to which these specimens were originally attributed, is very similar to the Red Sea variety of E. dispar. The tip of its simple superior seta is also encircled by small teeth but there is a slightly larger tooth behind the main fang (fig. 2 E).

2nd Red Sea variety

(fig. 2 F-H)

R e c o r d s : Elat, 7 m (1 spec.) - 16.2.1967; Ras Muhammad, 1.5 m (1); 2 m (1) - 18.9.67.

R e m a r k s : This variety (fig. 2 F) which is similar in most respects to the varieties of E. dispar, described earlier, is distinguished by having narrow-bladed spinigerous setae (fig. 2 G), commencing on setiger 7 instead of setiger 1. In addition, both simple setae are smoothly

bifid (fig. 2 H).

Each of the above mentioned varieties have slight differences which may prove to be of sub-specific value. However, since E. dispar apparently occurs in a number of variations, the erection of higher taxonomic categories is being postponed until a further comparative study can be undertaken.

Exogone gesae sp. nov.

(fig. 2 I-O)

R e c o r d s : Elat, 1,5 m (a sexual male) - 13.7.1967; 3 m (a female with larvae) - 8.11.65; 7 m (13 specimens, including a sexual male and a female with eggs) - 12.2.67; 10 m (1 spec.); 15 m (3 specimens, including a sexual male) - 8.10.65.

M a t e r i a l : Syntypes and paratypes will be deposited in the U.S.N.M., the Hebrew University of Jerusalem, the Museum of Hamburg and the University of Cape Town.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) in shallow waters, on sandy and silty sand sediments.

D e s c r i p t i o n : Length up to 2 mm for 25 setigers. Maximum width 0.12 mm. Anterior end (fig. 2 I)

with short, ventrally bent and dorsally fused palps; three fusiform antennae, the median one reaching the tip of the palps; two pairs of lensed eyes and one pair of rudimentary tentacular cirri. Proventriculus ball-shaped or ovoid. Pharynx with a single, dorsal tooth. Dorsal cirri short and rounded, missing from setiger 2. Ventral cirri digitiform, shorter than the parapodial lobe. All setigers with a simple pincer-shaped seta (fig. 2 M) and an internal strong aciculum (fig. 2 N). Compound setae of anterior segments (fig. 2 J), with a long beak which gradually shortens in posterior segments (fig. 2 L). A single spinigerous seta (fig. 2 K), superior to the compound setae, commences on setiger 4. A simple, slightly toothed inferior seta (fig. 2 O) in middle and posterior segments. Long natatory setae, from 10th setiger, in sexual males. Two anal cirri, up to twice as long as the median antenna. One sexual male with a split anal cirrus. Large eggs and larvae, singly attached to the ventral side of the parapodia, in middle and posterior segments.

R e m a r k s : The new species is distinguished by its simple pincer-shaped superior seta and by the single spiniger which commences on setiger 4. It resembles E. brevipes (Claparède), as described by Fauvel (1923), in possessing similar compound setae, fusiform antennae and a rounded proventriculus. The latter species, however, has 1 - 2 spinigers on each setiger and also possesses a dorsal cirrus on setiger 2.

FIGURE 2: Exogone dispar

1st Red Sea variety

(A) Profile and edge-on view of simple superior setae.

(B) Simple inferior seta.

(C) Falcigerous seta.

(D) Spinigerous seta.

South African variety

(E) Simple superior seta.

2nd Red Sea variety

(F) Anterior end.

(G) Spinigerous seta.

(H) Superior and inferior simple setae.

Exogone gesae n.sp.

(I) Anterior end.

(J) Compound seta from anterior segment.

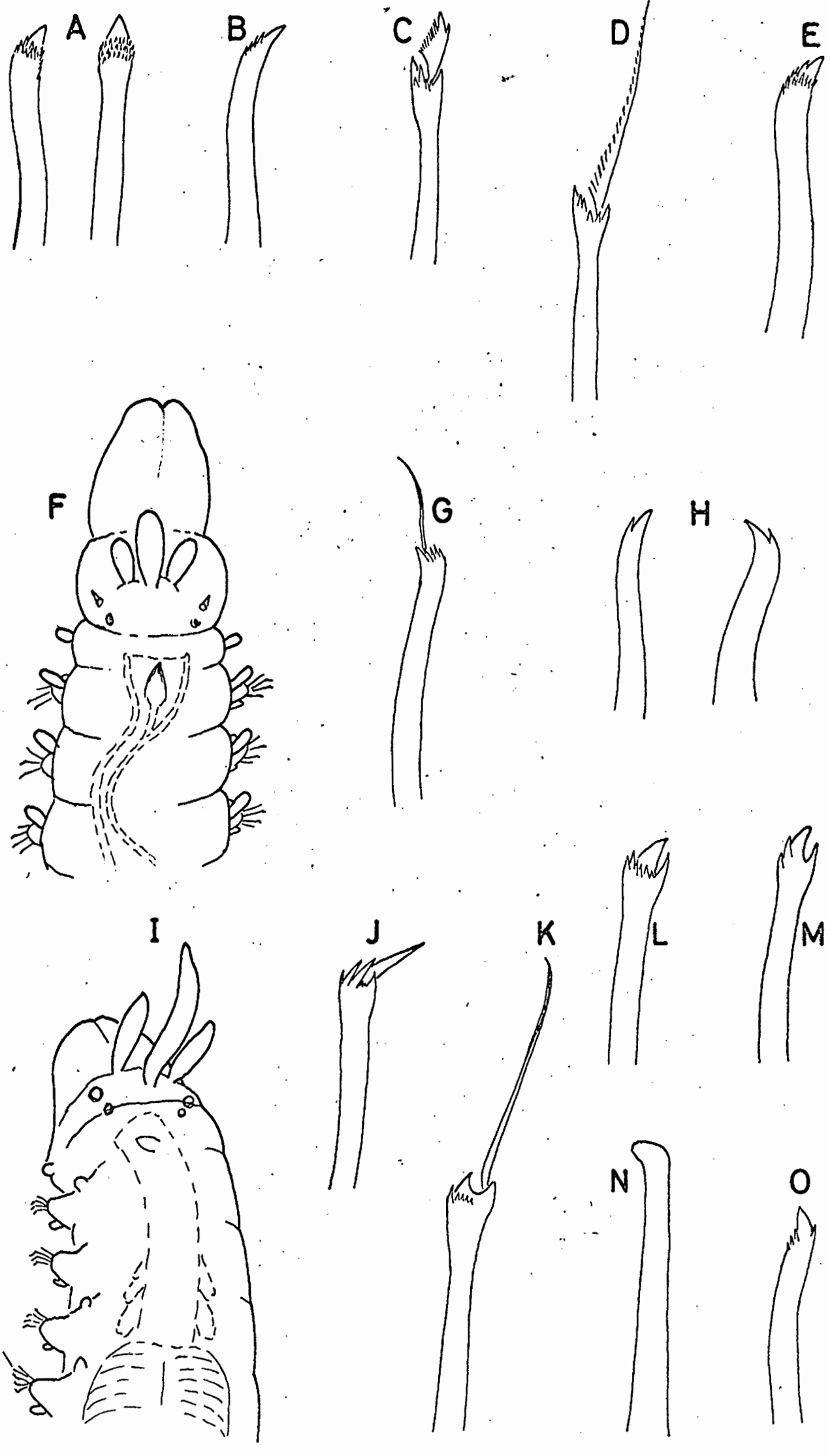
(K) Spinigerous seta.

(L) Compound seta from posterior segment.

(M) Superior simple seta.

(N) Aciculum.

(O) Inferior simple seta.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Exogone reichii sp. nov.

(fig. 3 A-J)

R e c o r d s : Elat, 250 m (1 spec.) - 16.6.1966.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), on sand-silt-clay sediments.

D e s c r i p t i o n : Length about 7 mm for 53 setigers. Maximum width, at the abdomen, 0.15 mm. Anterior end (fig. 3 A) with very long, pointed and dorsally fused palps; three antennae, the median one much longer than the palps; two pairs of red eyes and one pair of rudimentary tentacular cirri. Dorsal and ventral cirri short, present on all setigers. A specialised compound seta (fig. 3 D) with a narrow blade, a stout shaft and a broad, flattened shaft-head, on setiger 1. Parapodia of anterior segments (fig. 3 B) with narrow acicula and superior simple seta; 4 - 7 falcigerous setae (fig. 3 F) and a spinigerous seta (fig. 3 E) which replaces the specialised one. Posterior segments with superior simple seta (fig. 3 C) and stouter acicula (fig. 3 H); spiniger (fig. 3 I) and falcigers (fig. 3 J) of a slightly changed shape and a bifid inferior simple seta (fig. 3 G). Posterior end in a tube-like membrane, to which dirt adheres.

R e m a r k s : The new species is distinguished by its

FIGURE 3: Exogone reichii n.sp.

(A) Anterior end.

(B) Parapodium from 4th setiger.

(C) Superior simple seta from posterior segment.

(D) Specialised seta from 1st setiger.

(E) Spinigerous seta from anterior segment.

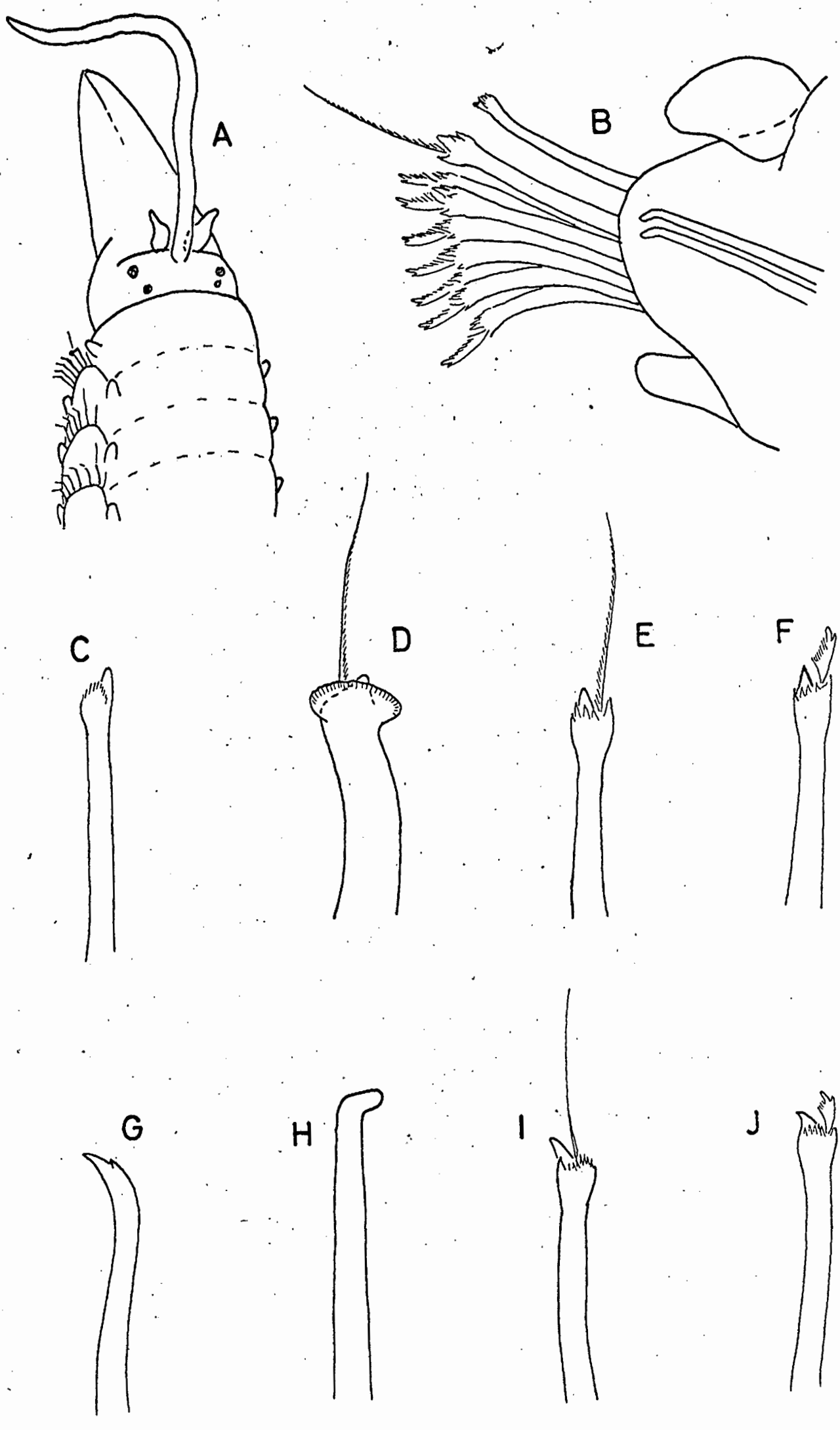
(F) Falcigerous seta from anterior segment.

(G) Inferior simple seta from posterior segment.

(H) Aciculum from posterior segment.

(I) Spinigerous seta from posterior segment.

(J) Falcigerous seta from posterior segment.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specialised stout seta on setiger 1. Exogone heterosetosa McIntosh, has also a specialised seta, but in this species, according to Day (1967, p. 274, fig. 12.10n), the shaft-head is swollen (not flattened) and the blade is quite broad.

Exosyllis subgen. nov.

T y p e - s p e c i e s : E. pettiboneae sp. nov.

D i a g n o s i s : Body small. Palps well developed and fused through most of their length. Three antennae and one pair of tentacular cirri. Dorsal and ventral cirri digitiform. Pharynx with a single tooth. Falcigerous setae with blades twice as long as the normal ones, in anterior segments. A simple superior seta and an inferior one at least in posterior segments.

Exogone (Exosyllis) pettiboneae sp. nov.

(fig. 4 A-H)

R e c o r d s : Elat, 250 m (2 spec.) - 16.6.1966; 270 m (2) - 16.2.67; 300 m (1); 400 m (1); 550 m (2) - 13.7.67; 800 m (7) - 27.9.67.

M a t e r i a l : Syntypes and paratypes will be deposited in the U.S.N.M., the Hebrew University, the British Museum and the University of Cape Town.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) in deep water, on sand-silt-clay and clayey silt sediments.

D e s c r i p t i o n : A thread-like body, up to 4 mm long for 42 setigers and a maximum width of 0.1 mm. Anterior end (fig. 4 A), with very long, pointed and dorsally fused palps; three antennae the median one about twice the length of the palps; two pairs of coalescent, orange eyes and a pair of rudimentary tentacular cirri. Dorsal and ventral cirri digitiform (fig. 4 B). No dorsal cirrus on setiger 2. Anterior parapodia with 1 - 2 acicula (fig. 4 C); several falcigerous setae with normal, moderate blades (fig. 4 D); a simple, superior seta (fig. 4 F) and 1 - 3 long-bladed falcigers (fig. 4 E) which gradually disappear in middle segments. A delicate, inferior, simple seta (fig. 4 G) in posterior segments. Two anal cirri, usually long and slender, sometimes short and ovoid. One specimen with a pair of ciliated nuchal organs between the antennae and the tenacular cirri (fig. 4 H).

R e m a r k s : Ciliated nuchal organs are reported in some American species (Pettibone, 1963 : 129) and can therefore not be considered a specific character.

The antennae of the new species are similar to those found in Exogone but long-bladed falcigerous setae are more common in Brania and Sphaerosyllis. The digitiform dorsal cirri are unlike those of Exogone which are usually small

and ovoid, or those of Sphaerosyllis which, like the antennae, are mostly onion-shaped or piriform.

Since Exogone is already represented by over 40 species, it is desirable to limit the genus to typical species only. The proposed new subgenus is distinguished from Exogone in having digitiform dorsal cirri and long-bladed falcigerous setae instead of spinigerous ones.

FIGURE 4: Exogone (Exosyllis) pettiboneae n.sp.

(A) Dorsal view of anterior end.

(B) Parapodium from posterior segment.

(C) Aciculum.

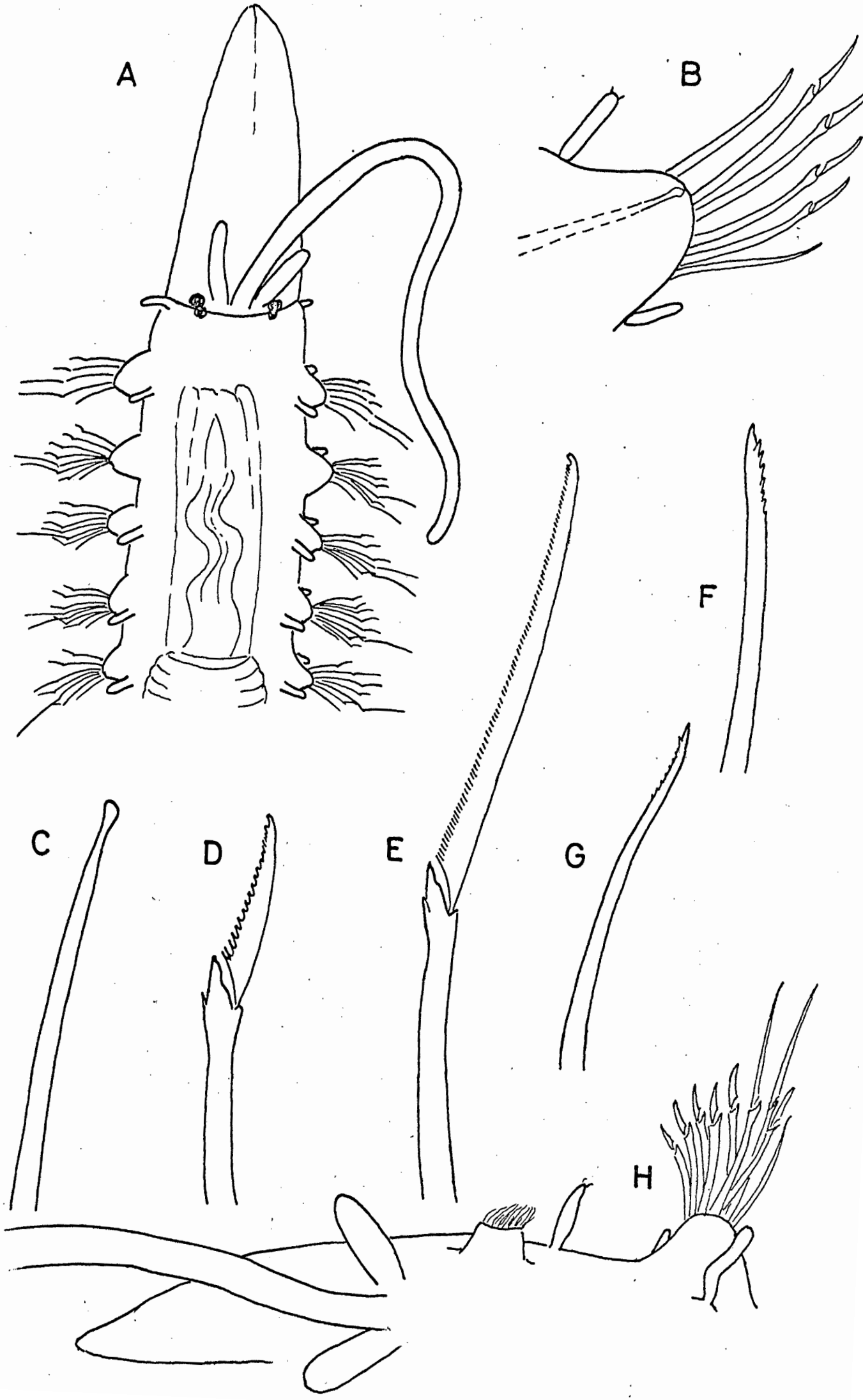
(D) Normal falcigerous seta.

(E) Long-bladed falciger from anterior segment.

(F) Superior simple seta.

(G) Inferior simple seta from posterior segment.

(H) Anterior end with a ciliated nuchal organ.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Sphaerosyllis Claparède, 1863

Sphaerosyllis hystrix Claparède 1863

(fig. 5 A-C)

Sphaerosyllis hystrix: Fauvel, 1923 : 301, fig. 115 g-k.

Sphaerosyllis hystrix var. capensis Day 1953 : 420, fig. 3 g-l.

? S. capensis serrata Hartmann-Schröder, 1960 : 103, fig. 118-120.

S. hystrix: Pettibone, 1963 : 136, fig. 35 g.

S. capensis Day, 1967 : 276, fig. 12.11. g-j.

S. hystrix Hartmann-Schröder and Stripp, 1968 : 13, fig. 6 a-c.

R e c o r d s : Elat, 0.5 m (3 spec.) - 16.6.1966; 3 m (7) - 8.11.65; 60 m (8) - 16.2.67; 1.5 m (1); 3 m (4); 5 m (15); 10 m (4); 20 m (1); 48 m (8); 67 m (1) - 13.7.67; Marsa Abu Abad, 60 m (1) - 26.9.67; Ras Muhammad, 1.5 m (33); 2 m (29); 3 m (1) - 18.9.67.

D e s c r i p t i o n : Body up to 2.4 mm long for 27 setigers, lightly covered with small, transparent papillae. Palps fused and bent ventrally. Proposcis with a single dorsally situated tooth. Two pairs of coalescent eyes. Three long piriform antennae and one pair of tentacular cirri. Dorsal cirri similar to the antennae and as long as the setal lobe. Dorsal cirri always lacking from setiger 2.

Ventral cirri digitiform and shorter than the setal lobe. Fibrillated dorsal capsules from setiger 4 onwards. Parapodia with a superior, minutely toothed simple seta (fig. 5 A) and several compound setae each with a unidentate blade. An inferior simple seta with a curved tip (fig. 5 B) appears in posterior segments. Aciculum with a blunt, strongly bent tip (fig. 5 C). Two anal cirri, slightly larger than the dorsal cirri.

R e m a r k s : Fauvel's (1923) description of S. hystrix is somewhat misleading. He states that the dorsal cirrus on setiger 2 is often missing but his drawing (fig. 115,g) clearly shows a cirrus on that setiger. However, subsequent authors (Pettibone, 1963; Hartmann-Schröder and Stripp, 1968; Hartmann-Schröder, 1971) have described the species without the second cirrus. Since specimens recorded in this study, including several with attached larvae, all lacked a dorsal cirrus on setiger 2, this deficiency is considered to be a characteristic morphological feature. On the other hand, it is quite possible that either Fauvel or one of his predecessors have confused two species. Unfortunately none of Fauvel's references (Claparède, 1863; Soulier, 1904) is available in South Africa to help elucidate this point.

S. capensis serrata Hartmann-Schröder (1960) from Ghardaqa and Abomingar (Red Sea) differs from S. hystrix only in having its dorsal capsules commencing on setiger 7 instead of 4. During the course of this study numerous

specimens of S. hystrix with obviously missing capsules were observed. However a genuine S. capensis serrata was never found. It is therefore interesting to speculate whether the latter subspecies has a fairly limited distribution or whether it has been confused with an invalidated S. hystrix.

D i s t r i b u t i o n : Mediterranean; Black Sea; North Atlantic (east and west coasts); Pacific coasts of North America; Cape, South Africa; Red Sea.

Sphaerosyllis semiverrucosa Ehlers, 1913

(fig. 5 D-H)

S. semiverrucosa Ehlers, 1913 : 483, pl. 35, fig. 5-9; Day, 1967 : 276, fig. 12.11.a-e.

S. brevicirra Hartmann-Schröder, 1960 : 105, fig. 128-130.

R e c o r d s : Elat, 5 m (1 spec.); 20 m (2); 35 m (1) - 13.7.1967; 7 m (4) - 16.2.67; 15 m (2) - 8.10.65; 70 m (1) - 16.6.66. Marsa Abu Zbad, 60 m (1) - 26.9.67. Ras Muhammad, 1.5 m (20); 2 m (13) - 18.9.67.

D e s c r i p t i o n : Body up to 2.8 mm long for 25 setigers; extensively covered with minute papillae which are much smaller than the dorsal cirri. Post-proventriculus segments with adherent dirt. Palps short, fused dorsally and bent ventrally. Pharynx with a single tooth. Two pairs of coalescent eyes. Three short, onion-shaped

antennae and one pair of similar but smaller tentacular cirri. Dorsal cirri shorter than the setal lobes and present on all setigers; the anterior ones (fig. 5 D) similar to the antennae but most of the following ones having 1 - 3 small papillae (fig. 5 E). Terminal portion of the dorsal cirrus sometimes retracted into its base. Ventral cirri short and digitiform. Simple setae of two kinds; a superior, stout one (fig. 5 F) in all parapodia and an inferior, delicate one (fig. 5 G) in posterior setigers. Compound setae with short, falciform blades the serrated portion of which (even in anterior setigers) is only 1.1 - 1.6 times longer than the pointed apex of the shaft (fig. 5 H). Eggs and larvae, singly attached below the dorsal cirri, commence on setiger 8.

D i s t r i b u t i o n : False Bay, South Africa; Ghardaqa, Red Sea.

R e m a r k s : Examination of South African specimens of S. semiverrucosa reveal that, like those from the Red Sea, they too have the same inferior, simple setae (fig. 5 G) on posterior parapodia. The sole differences between specimens from these two regions is one of size; those from the Gulf of Elat being about 40 percent smaller.

Sphaerosyllis xarifae Hartmann-Schröder, 1960

(fig. 5 I,J)

S. xarifae Hartmann-Schröder, 1960 : 103, fig. 121-124.

R e c o r d s : Elat, 3 m (3 spec.); 10 m (2) - 13.7.1967. Ras Muhammad, 1.5 m (14); 2 m (5); 3 m (1); 4 m (2) - 18.9.67.

R e m a r k s : S. xarifae is closely related to S. semiverrucosa and both species are often found together in shallow waters. S. xarifae is distinguished from the latter species by the much longer blade of the anterior compound setae (fig. 5 J) and also by the dorsal cirri which are usually long, narrow and with a retractable terminal end (fig. 5 I). Posterior setigers with a delicate, inferior simple seta, in addition to the superior one, which is present in all parapodia.

Sphaerosyllis semiverrucosa papillosa subsp. nov.

(fig. 5 K-O)

R e c o r d s : Elat, 35 m (3 spec.); 48 m (38); 67 m (10); 94 m (4); 400 m (3) - 13.7.1967; 60 m (32); 200 m (2); 270 m (7) - 16.2.67; 70 m (2); 172 m (2); 250 m (6) - 16.6.66; 155 m (1) - 28.11.66; 800 m (3) - 27.9.67.

M a t e r i a l : Syntypes and paratypes will be deposited in the U.S.N.M., the Hebrew University of

Jerusalem, the Museum of Hamburg and at the University of Cape Town.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), in 48 m, on fine sand sediments.

D e s c r i p t i o n : Body up to 4.5 mm for 28 setigers. Post-proventriculus segments with adherent dirt and densely covered with dark papillae as big as the base of the antennae. Anterior end (fig. 5 K), with short, dorsally-fused palps; two pairs of coalescent eyes; three onion-shaped antennae with a retractable terminal end; and one pair of smaller tentacular cirri. Dorsal cirri similar to the antennae and present on all setigers but sometimes as long as the parapodial lobe in posterior segments. Ventral cirri, short and digitiform. All parapodia with a single superior simple seta (fig. 5 L) and 3 - 7 falcigerous ones. Anterior falcigers with an elongated blade, the serrated portion of which is at least twice as long as the pointed apex of the shaft (fig. 5 M). Posterior parapodia with a delicate inferior simple seta (fig. 5 N). Two anal cirri (fig. 5 O), twice as long as the parapodia lobe but often missing. Some males with natatory setae commencing on setiger 10.

R e m a r k s : The new subspecies is closely related to both the stem species and S. xarifae but it is distinguished from them by the possession of large dark papillae, hence its name. It also differs from S. semiverrucosa by the

possession of a long blade in the anterior falcigers. Ecologically, the two established species inhabit mainly shallow waters, up to 20 m deep, while the new subspecies is found below the depth of 30 m.

FIGURE 5: Sphaerosyllis hystrix

(A) Superior simple seta.

(B) Inferior simple seta from posterior segment.

(C) Aciculum.

Sphaerosyllis semiverrucosa

(D) Dorsal cirrus from anterior segment.

(E) Dorsal cirrus from middle segment.

(F) Superior simple seta.

(G) Inferior simple seta from posterior segment.

(H) Falcigerous seta from anterior parapodium.

Sphaerosyllis xarifae

(I) Parapodium from posterior segment.

(J) Falcigerous seta from anterior segment.

Sphaerosyllis semiverrucosa papillae n.subsp.

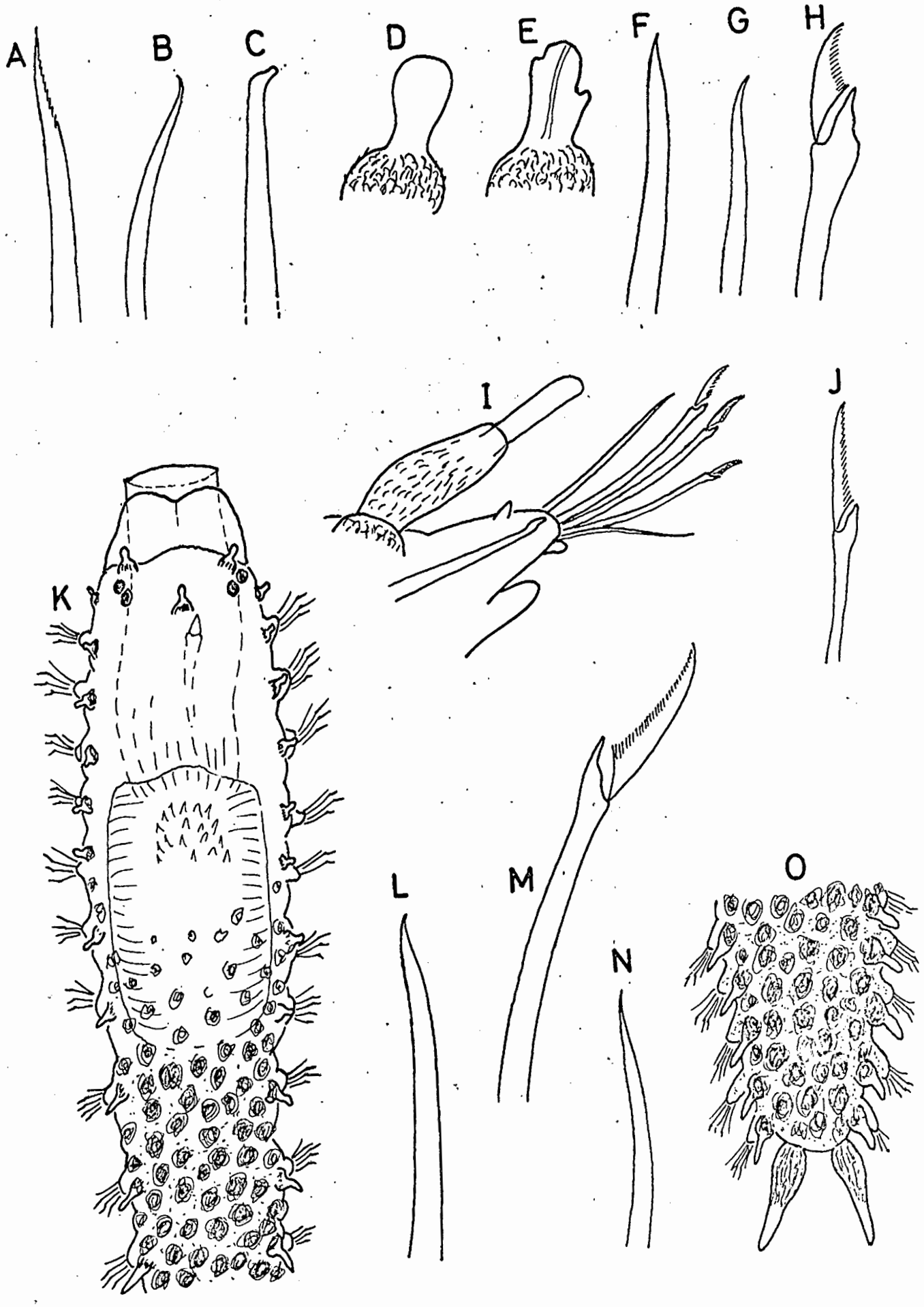
(K) Dorsal view of anterior end with pharynx partly everted.

(L) Superior simple seta.

(M) Falcigerous seta from anterior segment.

(N) Inferior simple seta from posterior segment.

(O) Dorsal view of posterior end.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PILARGIDAE Saint-Joseph

Dayius gen. nov.

T y p e - s p e c i e s : D. typicus sp. nov.

D i a g n o s i s : Body thread-like, subcylindrical with a ventral longitudinal groove and a smooth integument. Pharynx eversible and unarmed. Palps pointed, fused throughout, unarticulated but sometimes with a pair of ventrolateral papillae. Three antennae and two pairs of tentacular cirri. Dorsal and ventral cirri of moderate length, digitiform or pear-shaped, present on all setigers. Setae include a strong acicular seta superior to the dorsal cirri; winged capillaries; pointed acicular setae or toothed one, which may possess a narrow spine on top. Pygidium forked. Tubes soft, transparent, sometimes covered with mucus to which dirt adheres.

Dayius typicus sp. nov.

(fig. 6 A-E)

R e c o r d s : Elat, 67 m (1 spec.); 94 m (1) - 13.7.1967; 160 m (2) - 17.3.66; 155 m (1); 240 m (1) - 28.11.66; Marsa Abu Zbad, 60 m (2); Ras el Burqa, 230 m (7) - 23.9.67.

M a t e r i a l : Holotype and paratypes will be deposited in the U.S.N.M., the Hebrew University of Jerusalem, the British Museum and the University of Cape Town.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) in 155 m, on silty sand sediments.

D e s c r i p t i o n : A slender species 0.3 mm wide and 12 mm long for 40 setigers. Anterior end (fig. 6 A), with two triangular, dorsally-fused palps; a pair of pale eyes; three short, rudimentary antennae and two pairs of slightly longer tentacular cirri. Proventriculus muscular, very long and not clearly differentiated from the pharynx. Dorsal and ventral cirri digitiform or pear-shaped, slightly longer than the setal lobe (fig. 6 B). A single strong acicular seta, superior to the dorsal cirrus, commences on setiger 5. All parapodia with narrowly-winged capillaries most of which are gradually replaced by inferior, toothed acicular setae (fig. 6 C) in middle and posterior segments. Some of the toothed acicular setae are replaced by similar stout setae which have an additional narrow spine on top (fig. 6 D). Posterior end, with a furcated pygidium (fig. 6 E). Tubes soft and transparent, sometimes covered with dirt.

R e m a r k s : The new genus is distinguished by the possession of a tube which, according to Hartman (1947), is unknown among the pilargids; and by its pointed, unarticulated, fused palps. Unarticulated palps are known from Otopsis Ditlevsen (1917) but in this genus their anterior margin is broad and wrinkled, to give a fringed appearance. Furthermore, the latter genus has lamellated cirri; no ventral cirri on 1st setiger (Ushakov, 1955) and

it also lacks the superior acicular setae which are characteristic of the new genus. Similar straight and stout setae are common in Synelmis Chamberlin (1919), Loandalia Monro (1936), and also known from Ancistrosyllis McIntosh (1879). All of the above mentioned genera which originally were attributed to different families have now been placed in the Pilargidae (Pettibone, 1966).

A second species described herewith has palps with a pair of ventrolateral digitiform projections (fig. 6 A). These projections may represent palpostyles which are typical of most Pilargidae genera. However, in all of these genera the biarticulation of the palps is on the longitudinal axis whereas a similar pair of ventrolateral papillae is known from Ancistrosyllis rigida (Fauvel, 1919, 1953) and from Pettibone's (1966) redescription of Ancistrosyllis rigida under the name of Synelmis albini (Langerhans).

Having a muscular proventriculus as well as palps, tentacles and tentacular cirri similar to those found among the Exogoninae, Dayius is believed to represent an aberrant genus which links the Pilargidae to the Syllidae. This hypothesis could also be supported by the presence of spined acicular setae (fig. 6 D) which approach the shape of the shaft heads of compound spinigers of some syllids (fig. 2 K; fig. 3 E,I).

FIGURE 6: Dayius typicus n.sp.

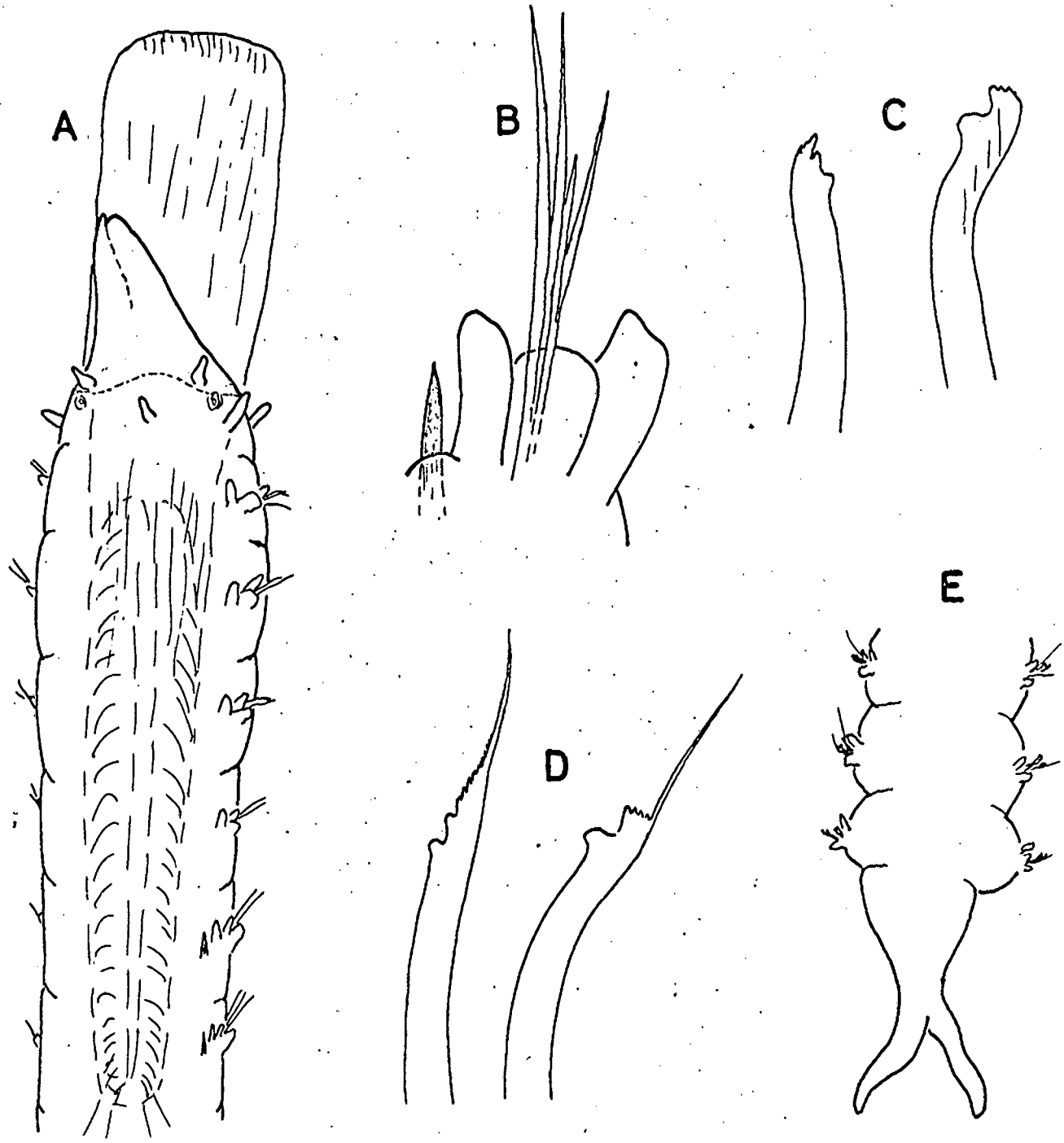
(A) Anterior end.

(B) Parapodium from 5th setiger.

(C) Toothed acicular setae from middle segments.

(D) Spined acicular setae from middle and posterior segments.

(E) Posterior end.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Dayius rullieri sp. nov.

(fig. 7 A-D)

R e c o r d s : Elat 160 m (2 spec.) - 17.3.1966; 196 m (3) - 16.6.66; 200 m (1); 270 m (1) - 16.2.67; 200 m (1) - 13.7.67.

M a t e r i a l : Holotype and paratypes will be deposited in the U.S.N.M., the Hebrew University of Jerusalem and the British Museum.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) in 200 m, on sand-silt-clay sediments.

D e s c r i p t i o n : A slender species, up to 22 mm long for 58 setigers, with a maximum width of 0.15 mm. Anterior end (fig. 7 A), with two fused palps each carrying a ventrolateral, digitiform projection (papilla); three rudimentary antennae; two pairs of short tentacular cirri and an eversible unarmed pharynx which is followed by a long proventriculus. Pigment spots scattered between the parapodia along the lateral lines. Each parapodium with slender, digitiform cirri and narrowly winged capillaries (fig. 7 B). Pointed acicular setae from setiger 6 or 7 onwards and a single strong one, superior to the dorsal cirrus, usually commencing on setiger 7 but sometimes on the 8th. Some anterior setigers with short winged setae (fig. 7 D). Posterior end with an achaetous segment followed by a forked pygidium (fig. 7 C). Tubes with a cover of mucus and dirt.

R e m a r k s : The new species is distinguished from the previously described Dayius typicus by the absence of toothed or spined acicular setae; by having the superior setae commencing on setiger 7 (or 8) instead of on 5 and by having a pair of ventrolateral papillae on its palps.

No proper eyes have been noticed in this species. However, a single incomplete specimen, collected in Elat from 10 m (13.7.67), was found to possess both ordinary eyes as well as pigmented spots along the lateral lines. The specimen which is relatively large, having a maximum width of 0.32 mm and a length of 23 mm for about 60 setigers, is similar in all other aspects to Dayius rullieri. Whether it represents a sexual form of this species or perhaps a subspecies will have to be decided from new material.

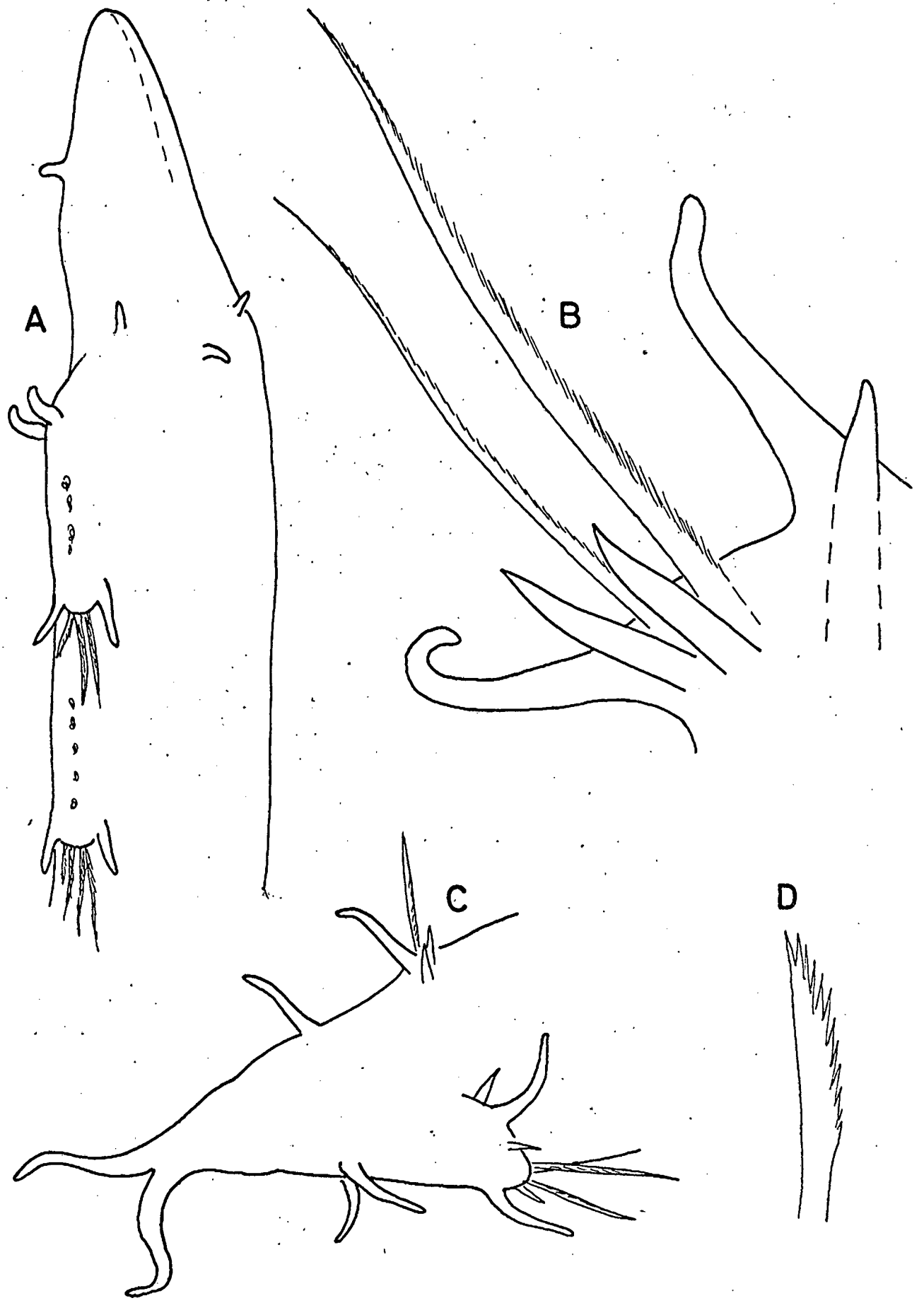
FIGURE 7: Dayius rullieri n.sp.

(A) Anterior end.

(B) Parapodium from 7th setiger.

(C) Posterior end.

(D) A short winged seta from 1st setiger.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CHAETOPTERIDAE Malmgren

Spiochaetopterus Sars, 1853

Spiochaetopterus costarum rubra subsp. nov.

(fig. 8 A-E)

R e c o r d s : Elat, 67 m (1 incomplete spec.); 94 m (empty tubes); 200 m (1 complete); 300 m, 400 m, 550 m (empty tubes) - 13.7.1967.

M a t e r i a l : Holotype and paratype will be deposited at the U.S.N.M. and the Hebrew University of Jerusalem.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) in 200 m, on sand-silt-clay sediments.

D e s c r i p t i o n : A slender species up to 20 mm long and a width of 0.4 mm. One pair of long grooved palps. Peristomium shovel-shaped. Prostomium ovoid, broader than long, with a pair of red eyes. Anterior region (fig. 8 A) of 9 setigers bearing unilobed notopodia with lanceolated setae (fig. 8 B). Setiger 4 with one stout, specialised seta accompanied by normal setae (fig. 8 C). Setiger 6 longer than the others, with a ventral dark gland. A ventral white gland on setigers 8 and 9. Middle region of 5 segments or more, bearing trilobed notopodia with a few fine setae embedded in the inner lobe and neuropodia with numerous delicate triangular uncini (fig. 8 D). The first 1 - 2 neuropodia unilobed, the rest bilobed with a small

upper lobe directed forward and a larger lobe directed backwards. Notopodia of posterior region, unilobed, supported by 1 - 2 hastate setae. Neuropodia bilobed and bearing uncini. Tubes horny, transparent, partly covered with dirt, with an external diameter of 0.5 mm (fig. 8 E).

R e m a r k s : The single complete specimen is a mature female extensively covered with eggs and faecal pellets which did not allow a proper examination of its middle and posterior regions. The 2nd specimen has only 14 setigers and the whole posterior region is missing. The new subspecies is closely related to S. costarum costarum from which it is distinguished by its red eyes, its remarkably small size and the possession of unilobed neuropodia on its 1st middle segment. The last two features are also found in S. bergensis (Gitay, 1959), but this Norwegian species has a long prostomium, no eyes and only two segments in its middle region.

FIGURE 8: Spiochaetopterus costarum rubra n.subsp.

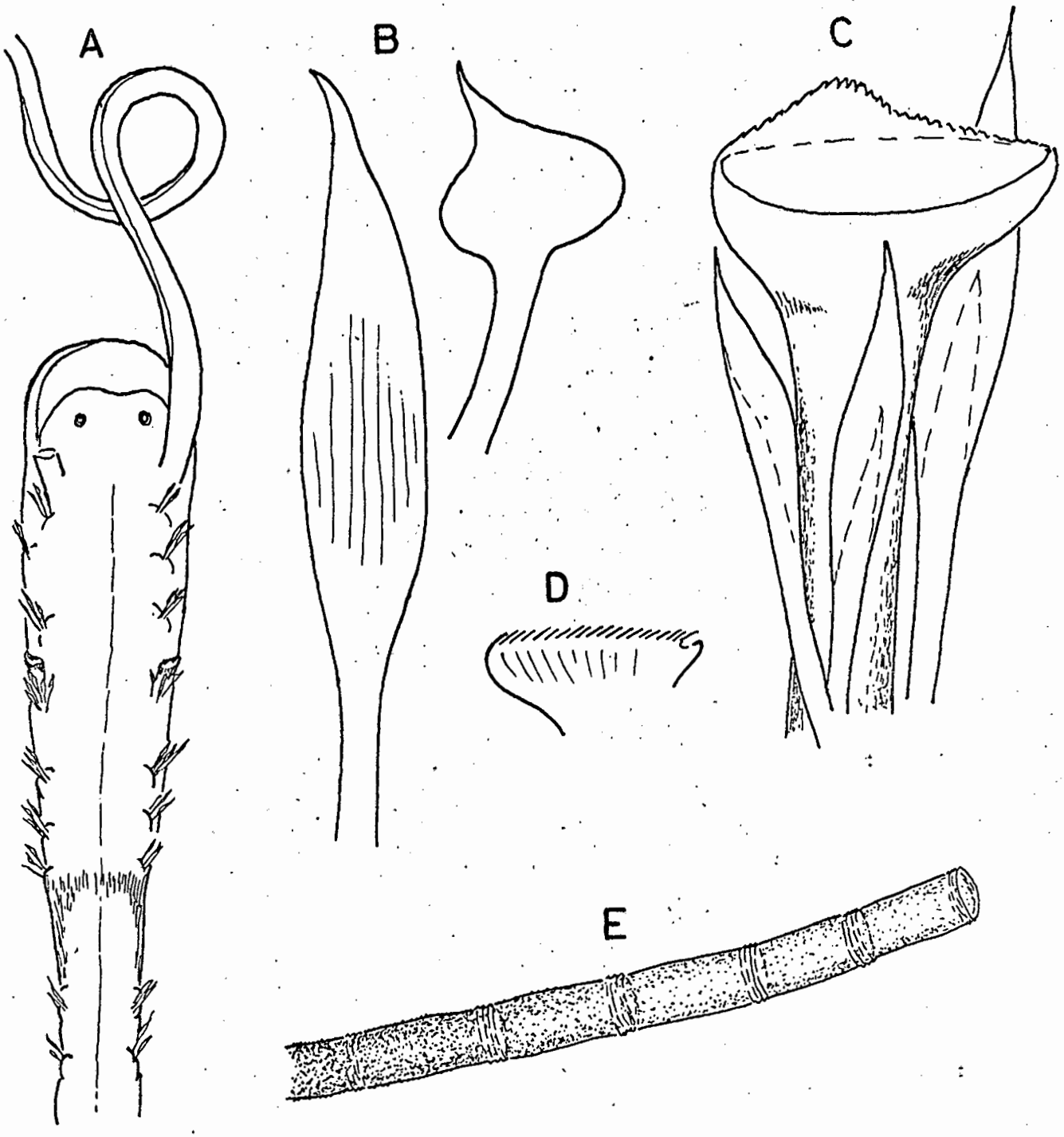
(A) Anterior end.

(B) Lanceolated setae from 1st setiger.

(C) Specialised seta and normal ones from setiger 4.

(D) Uncinus from middle segment.

(E) Tube.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FLABELLIGERIDAE Saint-Joseph

Elatana gen.nov.

T y p e - s p e c i e s : E. aqabensis sp.nov.

D i a g n o s i s : Body extensively covered with papillae; without a cephalic cage. Retractile cephalic lobe with a pair of palps and several tentacles of two kinds: compressed with frilly margins and filamentous. Setae, simple and annulated in both rami.

Elatana aqabensis sp.nov.

(fig. 9 A-D)

R e c o r d s : Elat, 1.5 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) on sand sediments.

D e s c r i p t i o n : Body 5 mm long. Maximum thoracic width 0.4 mm. 15 setigerous segments, all except the 3 - 4 posterior ones of similar thickness and with a dense covering of papillae. Anterior end (fig. 9 A) eversible, without papillae nor cephalic cage. Cephalic lobe with a pair of thickly grooved palps and eight tentacles of two kinds: four compressed, with frilly margins and four filamentous. Notosetae spear-shaped with peg-like annuli and a straight pointed tip (fig. 9 B). Neurosetae smooth,

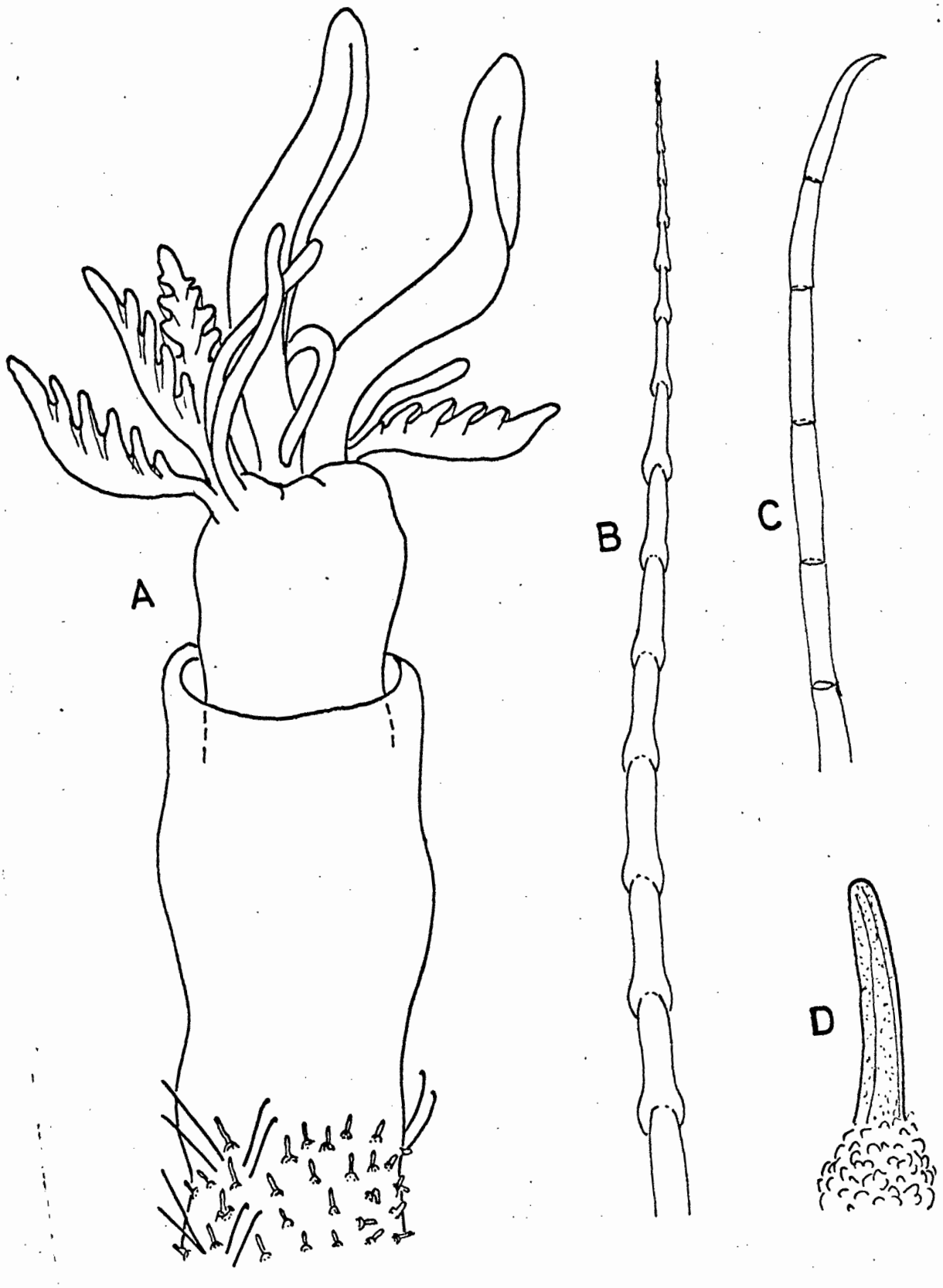
FIGURE 9: Elatana aqabensis n.sp.

(A) Ventro-lateral view of anterior end.

(B) Pegged notoseta.

(C) Neuroseta.

(D) Papilla.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annulated and with a faintly hooked tip (fig. 9 C). Skin papillae digitiform (fig. 9 D) with some of the dorsal ones longer than the rest. Posterior region well defined with uniformly narrow segments and few papillae. Anus terminal but in a ventral position.

R e m a r k s : The new genus is distinguished by the lack of a cephalic cage and by having frilly tentacles in addition to the filamentous ones. Brada Stimpson (1854), Fauveliopsis McIntosh (1922) and Flabelligella Hartman (1965) also lack a cephalic cage but none of these genera has frilly tentacles. The same applies to Diplocirrus Haase (1915) which, although usually possessing a cephalic cage, is similar to Elatana in having tentacles of two kinds.

Elatana porii sp.nov.

(fig. 10 A-D)

R e c o r d s : Elat, 10 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) on sand bottom.

D e s c r i p t i o n : Body 10 mm long for 14 setigerous segments all extensively covered with papillae. Anterior region with eight segments and a width of 0.4 mm. Anterior

division of Ampharetidae into two subfamilies should be redefined.

Aqabana laubieri sp.nov.

(fig. 11 F-H)

R e c o r d s : Elat, 300 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) on sand-silt-clay sediments.

D e s c r i p t i o n : Body tapered posteriorly about 3 mm long. Maximum thoracic width 0.3 mm. Buccal tentacles in a retracted position inside the mouth. Pigment spots unevenly scattered on the buccal and branchial regions (fig. 11 F). Two groups of four, closely-packed gills, three of which are smooth and arising in a transverse row and the 4th bipinnate and anteriorly situated. Two lateral ridges dorsally connected by a smooth transverse crest on setiger 2, embrace the branchial region. Thorax with 13 setigers bearing winged capillaries (fig. 11 H) on the notopodia and 11 uncinated neuropodia commencing on setiger 3. One pair of post-branchial acicular hooks (fig. 11 G) above a pre-emergent replacement pair embedded beneath. No fine acicular neurosetae on pre-uncigerous segments. Thoracic and abdominal uncini similar to those

described earlier (fig. 11 D,E) for A. confusa. Abdomen of about 25 segments bearing long uncinated neuropodia with supporting ligaments.

R e m a r k s : The new species is distinguished in having a single pair of bipinnate gills.

FIGURE 11: Aqabana confusa n.sp.

(A) Lateral view of anterior end.

(B) Acicular hook.

(C) Winged capillaries.

(D) Edge-on view and profile of thoracic uncinus.

(E) Abdominal uncinus.

Aqabana laubieri n.sp.

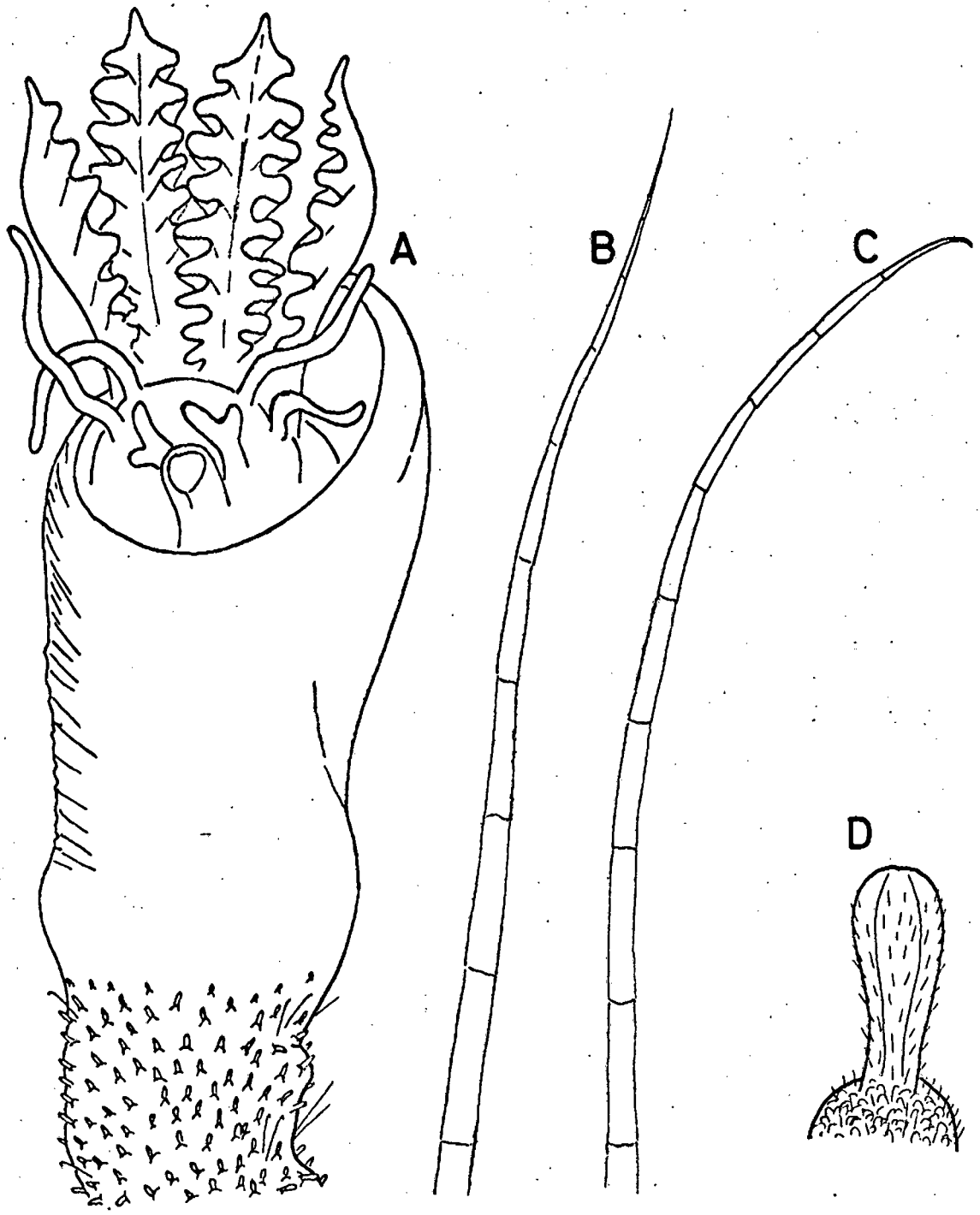
(F) Lateral view of anterior end.

(G) Acicular hook.

(H) Winged capillary.

long and coiled, with a ciliated groove and a rough surface. Two groups of four closely packed gills in a transverse row: the two lateral pairs smooth, the next pair bipinnate and the median pair, which is situated slightly forward, uneven in having a bipinnate gill on the left side of the mid-dorsal line and a smooth short and simple gill on the right. (The latter is believed to represent a bipinnate gill which has been deformed through injury.) Two lateral ridges, dorsally connected by a smooth transverse crest on setiger 4, embrace the branchial region. A pair of acicular hooks (fig. 11 B) post-branchially embedded on setiger 2. Thorax with 16 notopodial winged capillaries (fig. 11 C), the three first of which not fully developed and 12 uncinated neuropodia commencing on setiger 5. Each uncinus (fig. 11 D) with a single series of five fine teeth above the rostral point and the basal prow. Abdomen with about 16 projecting and uncinigerous pinnules with supporting ligaments. Abdominal uncini (fig. 11 E) with a few rows of teeth. Some anterior and lateral uncini slightly bigger and similar to the thoracic ones.

R e m a r k s : The new genus is distinguished in not having fine acicular neurosetae on pre-uncigerous segments. The absence of these neurosetae is characteristic of the Ampharetinae genera but Aqabana seems to be closer to the Melinninae (Chamberlin, 1919) in having post-branchial hooks, grooved tentacles and gills of two kinds which are typical to Isolda Müller (1858). It therefore emerges that the present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AMPHARETIDAE Malmgren

? Melinninae Chamberlin

Aqabana gen.nov.

T y p e - s p e c i e s : A. confusa sp.nov.

D i a g n o s i s : Buccal tentacles grooved and retractile. Gills of two kinds: smoothly filamentous and bipinnate. Two lateral ridges, dorsally connected by a transverse crest, embrace the branchial region. One pair of post-branchial acicular hooks, but no fine acicular neurosetae on pre-uncigerous segments. Setae as winged capillaries in the thoracic notopodia and uncini in the neuropodia. Twelve uncinigerous thoracic segments.

Aqabana confusa sp.nov.

(fig. 11 A-E)

R e c o r d s : Elat, 200 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) on sand-silt-clay sediments.

D e s c r i p t i o n : Body tapered, 6 mm long. Maximum thoracic width 0.5 mm. Pigment spots unevenly scattered on anterior region (fig. 11 A). Buccal tentacles

division of Ampharetidae into two subfamilies should be redefined.

Aqabana laubieri sp.nov.

(fig. 11 F-H)

R e c o r d s : Elat, 300 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) on sand-silt-clay sediments.

D e s c r i p t i o n : Body tapered posteriorly about 3 mm long. Maximum thoracic width 0.3 mm. Buccal tentacles in a retracted position inside the mouth. Pigment spots unevenly scattered on the buccal and branchial regions (fig. 11 F). Two groups of four, closely-packed gills, three of which are smooth and arising in a transverse row and the 4th bipinnate and anteriorly situated. Two lateral ridges dorsally connected by a smooth transverse crest on setiger 2, embrace the branchial region. Thorax with 13 setigers bearing winged capillaries (fig. 11 H) on the notopodia and 11 uncinated neuropodia commencing on setiger 3. One pair of post-branchial acicular hooks (fig. 11 G) above a pre-emergent replacement pair embedded beneath. No fine acicular neurosetae on pre-uncigerous segments. Thoracic and abdominal uncini similar to those

described earlier (fig. 11 D,E) for A. confusa. Abdomen of about 25 segments bearing long uncinated neuropodia with supporting ligaments.

R e m a r k s : The new species is distinguished in having a single pair of bipinnate gills.

FIGURE 11: Agabana confusa n.sp.

(A) Lateral view of anterior end.

(B) Acicular hook.

(C) Winged capillaries.

(D) Edge-on view and profile of thoracic uncinus.

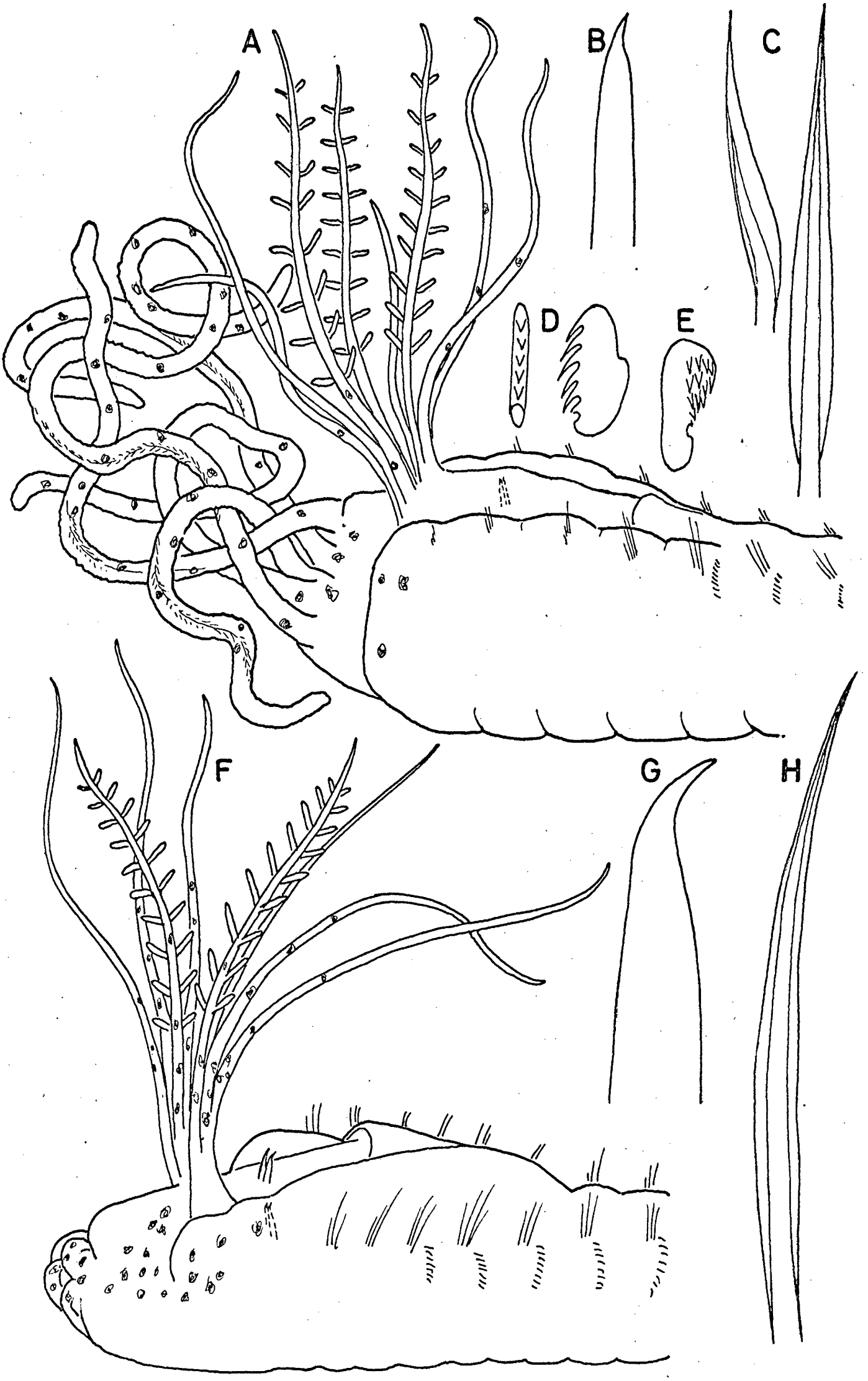
(E) Abdominal uncinus.

Agabana laubieri n.sp.

(F) Lateral view of anterior end.

(G) Acicular hook.

(H) Winged capillary.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TEREBELLIDAE Grube

Terebellinae Grube

Pista Malmgren, 1866

Pista arborescens sp. nov.

(fig. 12 A-D)

R e c o r d s : Elat, 1.5 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype dissected and mounted with polyvinyl lactophenol on three slides, will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), on a sand bottom.

D e s c r i p t i o n : Total length 3.5 mm for about 25 setigers. Tentacular lobe (fig. 12 A) with grooved tentacles of varying length, ventrally enclosed by a semicircular, lower lip. Edge of lower lip and tentacular grooves ciliated. Presetal segments with 2 - 3 glandular lateral lobes which are easily overlooked and a pair of papillated bush-like gills. One gill rudimentary and probably deformed by injury. Smooth-tipped winged capillaries (fig. 12 B) on 16 thoracic notopodia commencing on segment 4. Avicular uncini, from setiger 2, decreasing in size ventrally; uniserial in the first six tori; biserial, alterrate and set face to face on posterior thorax

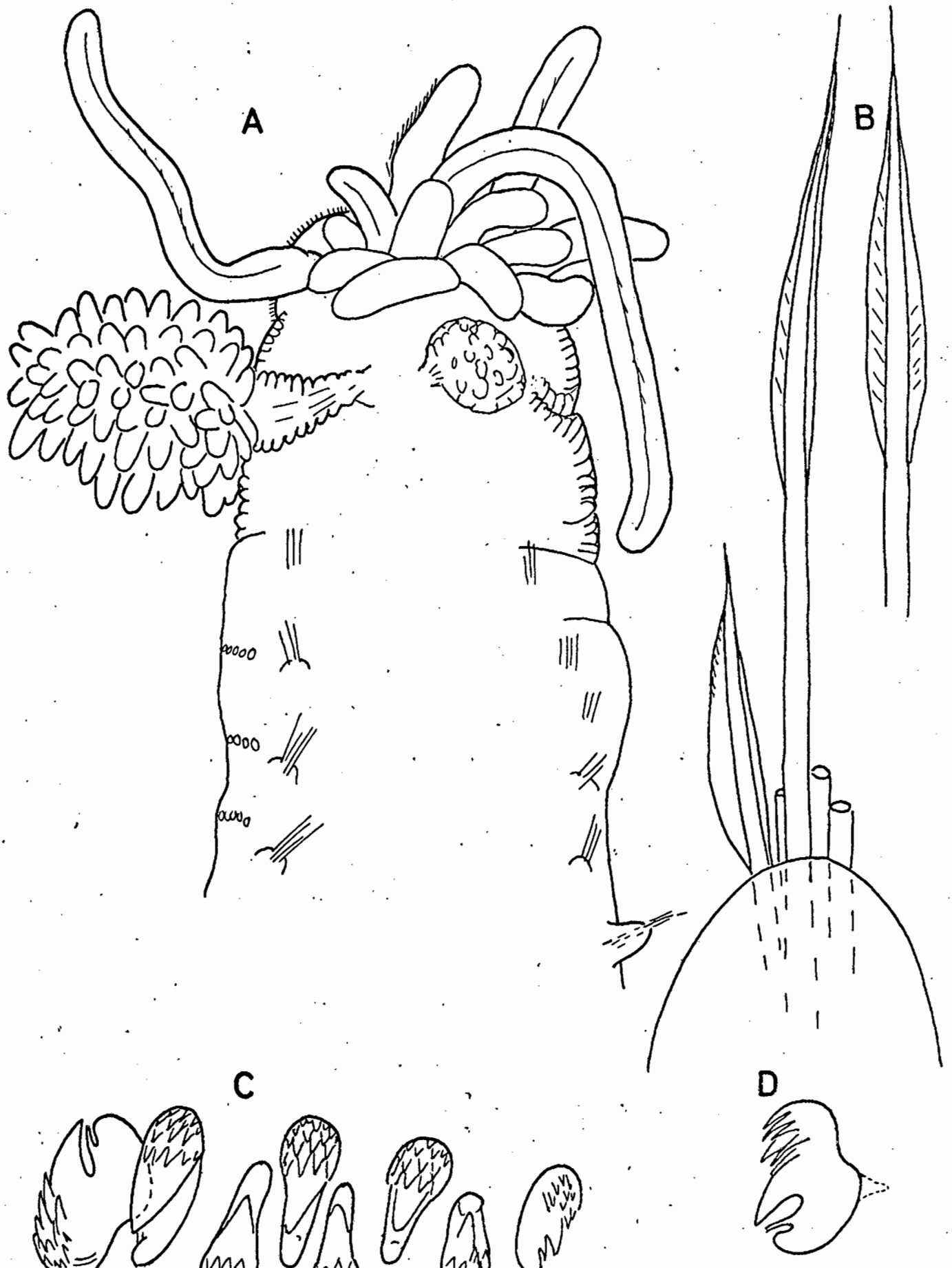
FIGURE 12: Pista arborescens n.sp.

(A) Anterior end.

(B) Notosetae from 7th setiger.

(C) Uncigerous biserial from setiger 8.

(D) Uncinus from first torus.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(fig. 12 C). Each uncinus with a short rounded base and 3 - 4 transverse rows of teeth on the vertex. First torus uncini with a delicate, poorly chitinised shaft (fig. 12 D). Abdomen of about seven uncinigerous segments. Neuropodia with small uncini and supported by delicate ligaments. Pygidium and tube unknown.

R e m a r k s : The new species resembles Pista maculata (Dalyell) as described by Fauvel (1927 : 263, fig. 91) in having 16 thoracic setigers and a single pair of branched gills. However, it differs from this species by possessing a papillated gill instead of a ramified one, and also by lacking a conspicuous shaft on the uncini of the first few tori. Another close species, Pista unibranchia Day (1963), has a single, median gill and 17 thoracic setigers.

Thelepinae Malmgren

Duothelepus gen. nov.

T y p e - s p e c i e s : D. elatensis sp. nov.

D i a g n o s i s : Thelepinae with collar-like tentacular lobe; one pair of presetal, filamentous gills; lateral lobes and ventral pads. Thoracic notosetae as smooth-tipped, winged capillaries, sometimes with a finely serrated edge. Avicular uncini, uniserial or biserial in posterior thorax, may possess a short shaft in the first torus.

Duothelepus elatensis sp. nov.

(fig. 13 A-F)

R e c o r d s : Ras el Burqa, 230 m (1 spec.) - 27.9.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Gulf of Elat (Aqaba), east of Ras el Burqa, on soft fine sediment.

D e s c r i p t i o n : Maximum thoracic width 0.5 mm. Total length 7 mm for about 56 setigers. Tentacular lobe (fig. 13 E) with a few grooved tentacles enclosed by a collar which projects ventrally as a shovel-shaped lower lip. Edge of lower lip and tentacular groove ciliated. One pair of simple, filamentous gills on 3rd segment. Segments 2 and 3 with conspicuous glandular lateral lobes, which extend across the dorsum. First pair of lobes ornamented with silvery stripes. Ventral pads on several anterior setigers (fig. 13 F). Notosetae commence on segment 4 and extend over 16 segments. Each tuft with 5 - 8 smooth-tipped, winged capillaries. Some posterior tufts contain 1 - 2 longer setae with a finely serrated edge (fig. 13 C). Avicular uncini, from setiger 2 onwards, decreasing in size ventrally; uniserial in first 6 tori; biserial, alterrate and set face to face on posterior thorax. Each uncinus with 3 - 4 series of teeth surmounting the main fang (fig. 13 A). First torus uncini with a short, faintly

FIGURE 13: Duothelepus elatensis n.sp.

(A) Profile and edge-on view of thoracic uncinus.

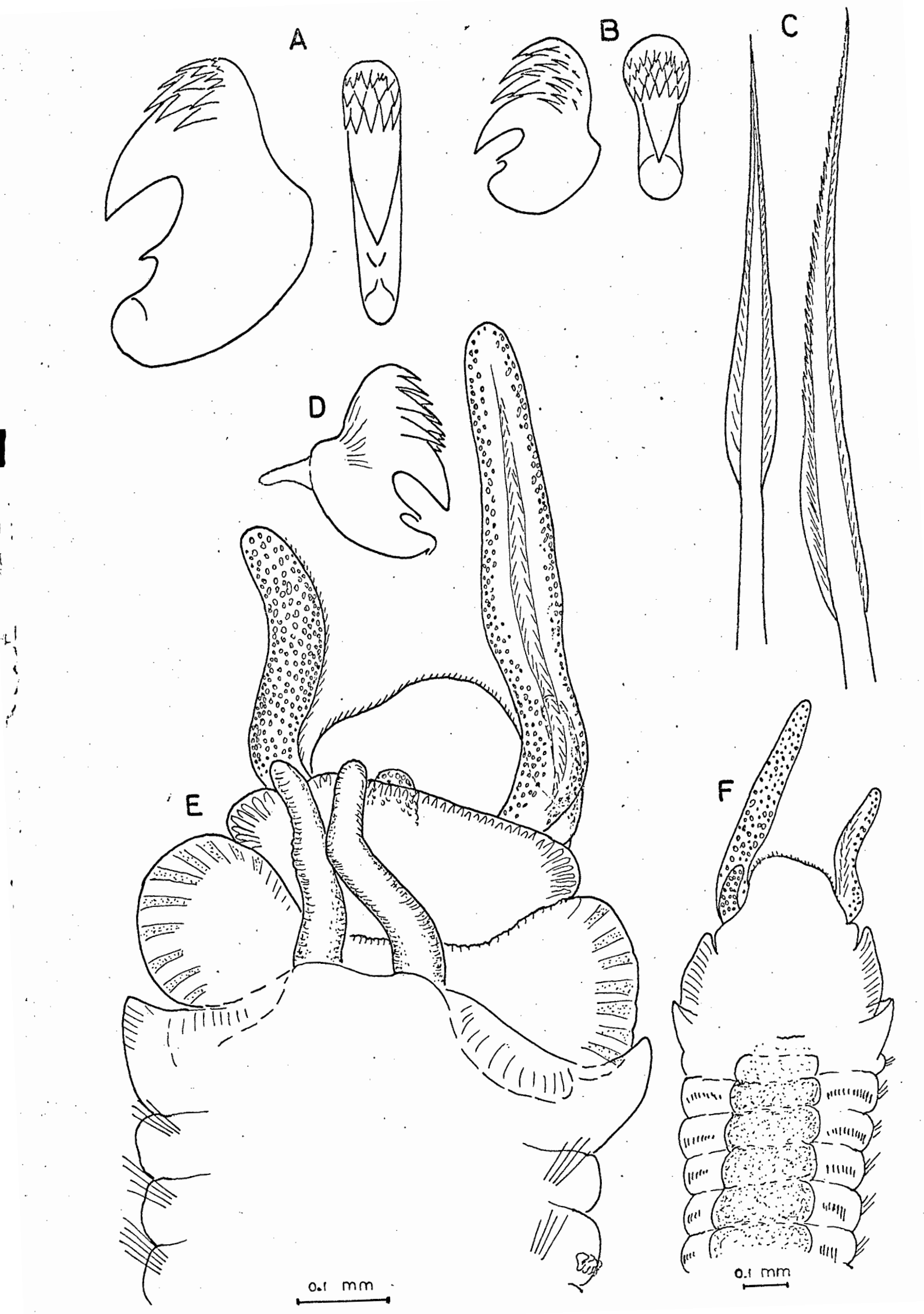
(B) Profile and edge-on view of abdominal uncinus.

(C) Thoracic winged capillaries.

(D) Uncinus from first torus.

(E) Dorsal view of anterior end.

(F) Ventral view of anterior end.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chitinised shaft which is easily broken or overlooked (fig. 13 D). Abdominal neuropodia supported by a few embedded ligaments, each connected to an uncinus with a well developed crown of teeth (fig. 13 B). Pygidium conical with a central dorso-ventral cleft. Tube soft, semi-transparent with irregularly attached organic particles.

R e m a r k s : The new genus resembles other genera of the Thelepinae in having simple gills, and Euthelepus McIntosh (1885) in possessing lateral lobes and ventral pads. It is distinguished, however, in having only one pair of filamentous gills which are located on a presetal segment.

Polycirrinae Malmgren

Polyuncinus gen. nov.

T y p e - s p e c i e s : P. hartmaniae sp. nov.

D i a g n o s i s : Polycirrinae with well developed tentacular lobe, ventral pad and uncinigerous neuropodia; but entirely without notosetae.

Polyuncinus hartmaniae sp. nov.

(fig. 14 A,B)

R e c o r d s : Ras Muhammad, 3 m (1 spec. - 18.9.62.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Ras Muhammad, southern tip of Sinai.

D e s c r i p t i o n : Body glandular, extremely swollen anteriorly, clearly annulated posteriorly (fig. 14 B). Length up to 16 mm for about 70 uncinigerous segments. Tentacular lobe large and expanded followed by 3 - 4 achaetous segments. No gills, eyes or lateral lobes. A muscular annulated ventral pad, segmentally defined only posteriorly, extends all along the body and harbours a median groove. Notosetae and notopodial lobes entirely absent. Thorax undefined. Neuropodial lobes, each with a single row of 10 - 12 avicular uncini, their number decreasing gradually toward the posterior end where only four remain. Each uncinus (fig. 14 A) with several small teeth surmounting a single long tooth above the main fang; a long triangular base and a backward projecting chitinous process which extends deep into the neuropodial base. Some middle and posterior segments with many eggs under the transparent integument. In the anterior swellings, which contain a considerable amount of partly digested food, compound and avicular setae could be recognised, indicating that the new species may be either a scavenger or predator of polychaete worms.

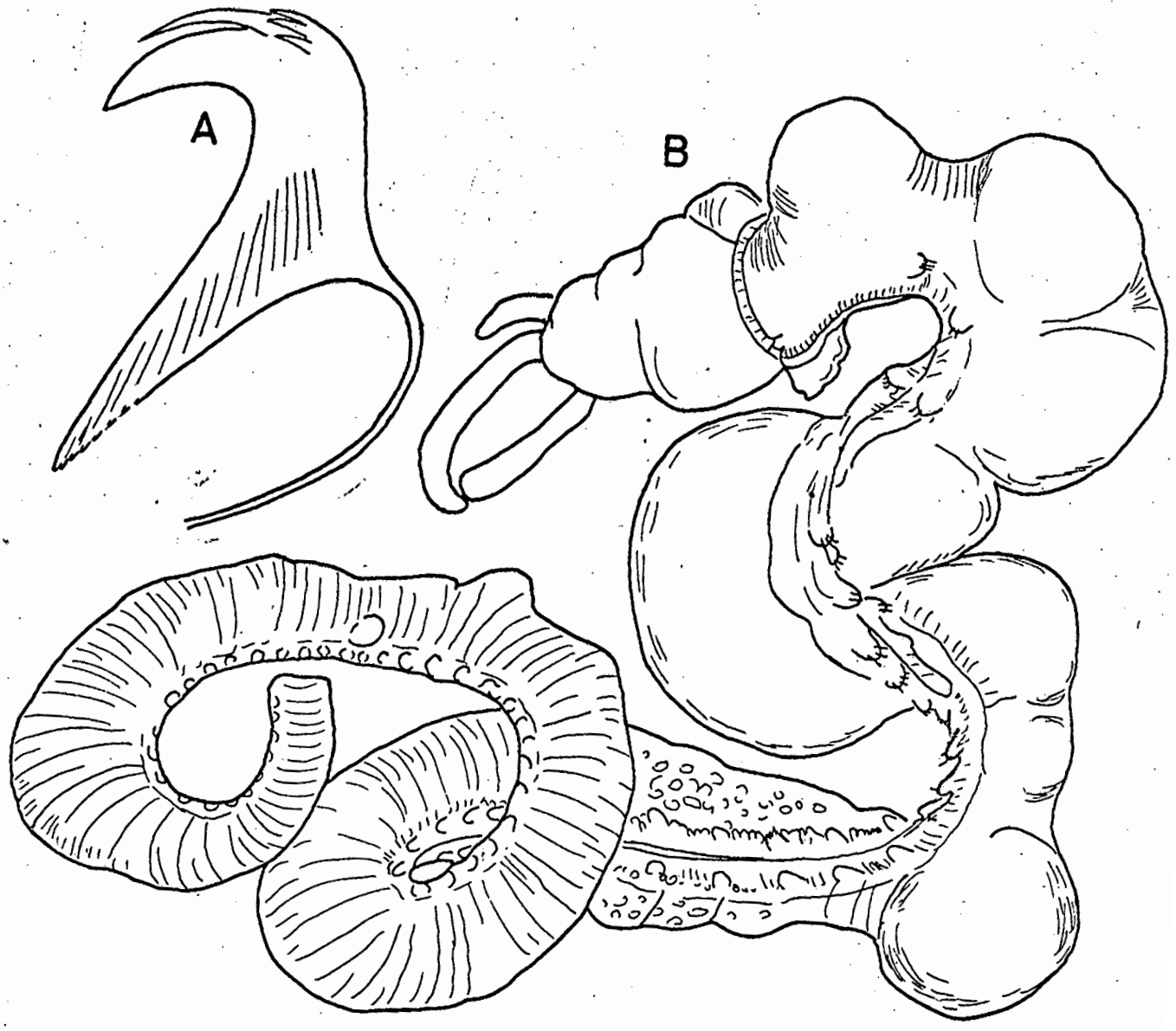
R e m a r k s : With the exception of Hauchiella Levinsen (1893), which has no setae at all, the new genus is distinguished from its associated abranchiate genera by not possessing notosetae. The large tentacular lobe of

Polyuncinus and in particular its long-based uncini, may indicate a close affinity to Polycirrus Grube (1850).

FIGURE 14: Polyuncinus hartmaniae n.sp.

(A) Neuropodial uncinus.

(B) Entire worm (thirty times life size).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B

TRICHOBRANCHIDAE Malmgren

Terebellides Sars, 1835

Terebellides parvus sp. nov.

(fig. 15 A-E)

R e c o r d s : Elat, 94 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba) on fine sand sediments.

D e s c r i p t i o n : Total length 3 mm, of which the unequal grooved tentacles make up $^1/_3$. A single gill on segment 2, with 1 - 2 poorly ramified branches and a pair of developed branches, each lamellated basally but with mere stylodes towards its tip (fig. 15 A). Both forms of branchial "leaves" are heavily coated with delicate cilia. Notosetae on 18 thoracic segments commencing on segment 3. They are smooth-tipped, narrowly winged capillaries and also include spinulose setae (fig. 15 B). A single bent acicular neuroseta on setiger 5. Setiger 6 with both bent acicular and a long-shafted hook (fig. 15 E). Neuropodia of setigers 7 - 11 with long-shafted hooks only; those of setigers 12 - 16 with both hooks and uncini; setigers 17 - 31 with uncini only. Avicular uncini borne on long neuropodial pinnules. Each uncinus (fig. 15 C) with 2 - 3

FIGURE 15: Terebellides parvus n.sp.

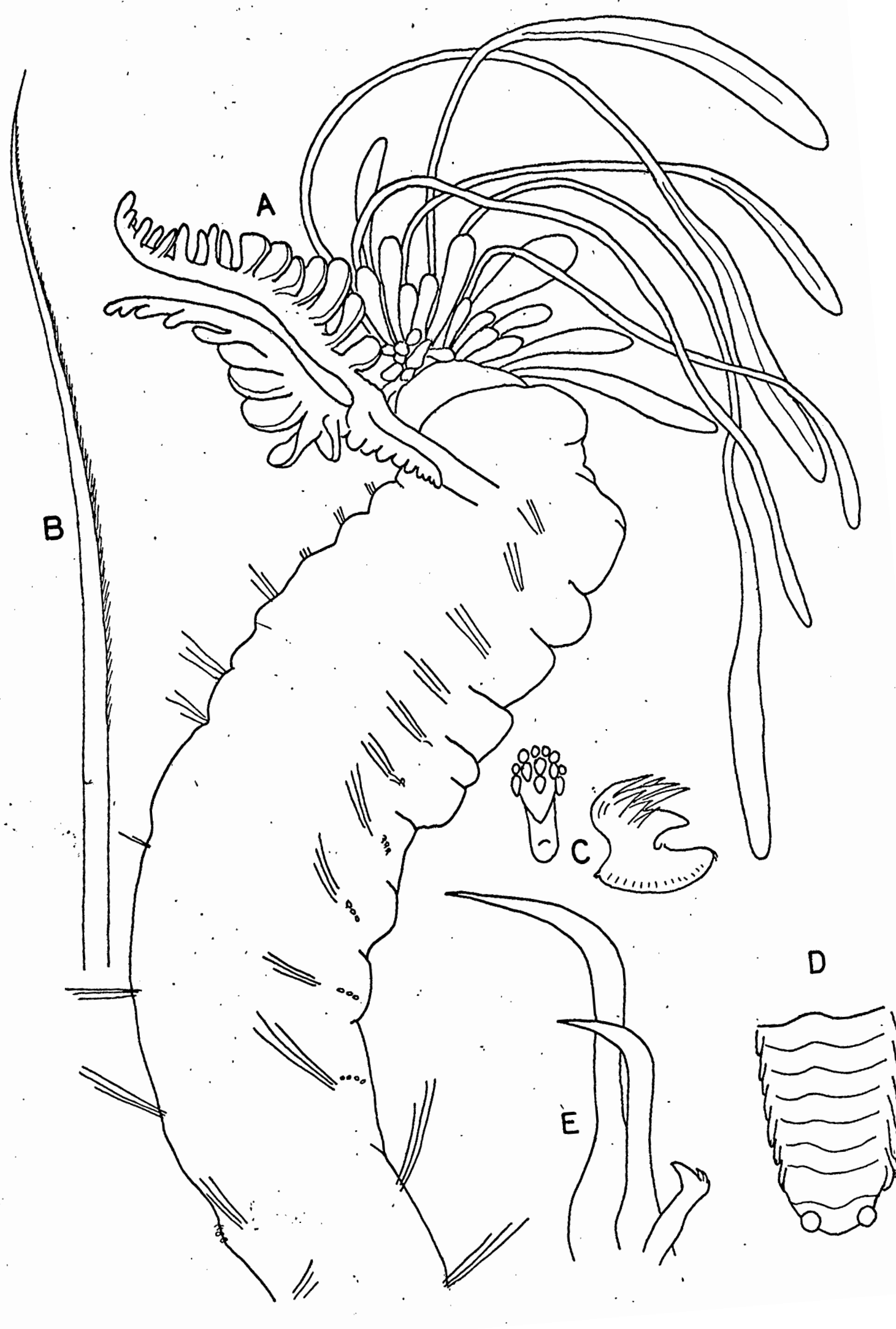
(A) Dorso-lateral view of anterior end.

(B) Thoracic spinulose seta.

(C) Edge-on view and profile of uncinus from 5th abdominal segment.

(D) Ventral view of posterior end.

(E) Bent acicular neurosetae and long-shafted hook from setiger 6.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rows of teeth surmounting the main fang and a base with three attachment points. A ventral groove runs along the body. Pygidium (fig. 15 D), with a pair of spherical cavities.

R e m a r k s : The new species resembles Terebellides stroemii in its general shape but is distinguished by its peculiar gill which bears both lamellae as well as styloid "leaves" and by having its neurosetae commencing on setiger 5 instead of 6. T. parvus is remarkably small and the possibility that it is a juvenile form should not be excluded. However, similar small but mature specimens are not uncommon in the present collection.

Trichobranchus Malmgren, 1866

Trichobranchus roseus malmii subsp.nov.

(fig. 16 A-D)

R e c o r d s : Elat, 7 m (1 spec.) - 16.2.67.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), on sand bottom.

D e s c r i p t i o n : Body short, stout and tapering posteriorly. Length 6 mm for 23 setigers. Maximum thoracic width 1 mm. Tentacular lobe (fig. 16 B) with

numerous tentacles and a ventrally situated shelf-like lower lip. One pair of large lateral lappets. Two pairs of simple filamentous gills. Winged notopodial capillaries (fig. 16 A) and long-shafted hooks (fig. 16 C) commence on segment 6 and extend over 15 segments. Abdomen with a mid-dorsal longitudinal groove and eight projecting neuropodia which bear avicular uncini. Each uncinus (fig. 16 D) with two rows of teeth above the main fang.

R e m a r k s : The new Red Sea subspecies is similar to Filibranchus roseus Malm, as described by Hartman (1965) from the Australian New England region. However, the description of F. roseus is incomplete, especially with regard to the neurosetae. Hartman's specimen is only 9 mm long, whereas the original Swedish specimen (Malm, 1874 p.99) has a length of 35 mm. Being alopatric varieties, the three specimens should probably occupy different taxonomic categories.

Filibranchus Malm (1874) differs from Trichobranchus Malmgren (1866) only in having two pairs of filamentous gills instead of three as in the latter genus. The two genera were combined by Hessle (1917), as well as Eliason (1962, p.81) who have pointed out that the type specimen of F. roseus contains 15 thoracic setigers and not 17 as reported by Malm (1874).

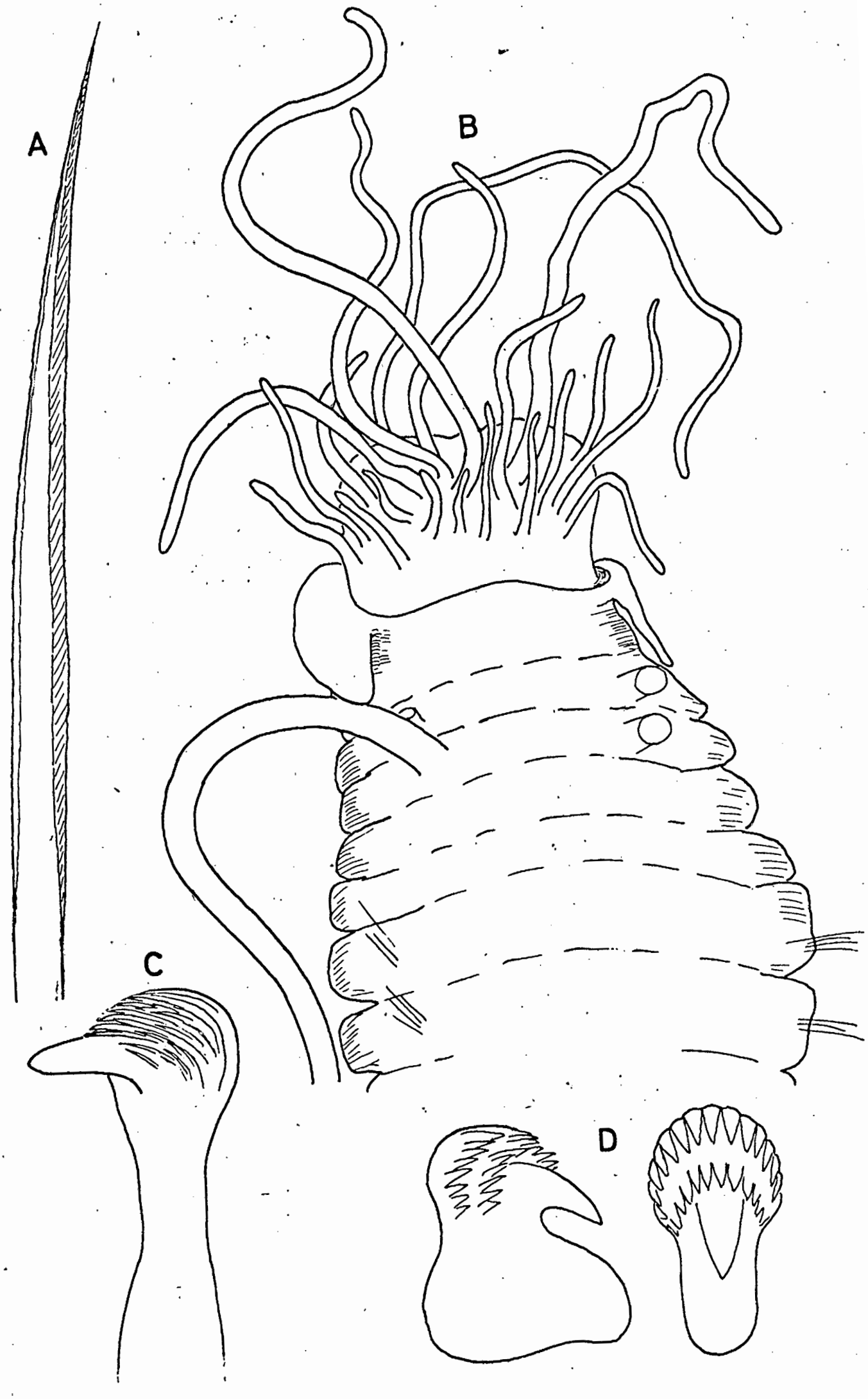
FIGURE 16: Trichobranchus roseus malmii n.subsp.

(A) Thoracic winged capillary.

(B) Dorsal view of anterior end.

(C) Neuropodial hook from thorax.

(D) Profile and edge-on view of abdominal uncinus.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SABELLIDAE

Sabellinae Rioja

Cornipotamiles gen nov.

T y p e - s p e c i e s : C. israeli sp.nov.

D i a g n o s i s : Sabellinae with a pair of conspicuous horny hooks projecting dorsally from the base of the branchial lobe. Two well-developed collars. Thorax with winged capillaries and palae in the neuropodia; avicular uncini and pick-axe setae in the notopodia. Abdomen with avicular uncini in the notopodia; capillaries and pick-axe setae in the neuropodia.

Cornipotamiles israeli sp.nov.

(fig. 17 A; 17 B-H)

R e c o r d s : Ras el Burqa, 35 m (1 spec.) - 27.9.1967.

M a t e r i a l : Holotype, together with two slides, will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Ras el Burqa, northern part of the Gulf of Elat (Aqaba), in a dredged coral mass.

D e s c r i p t i o n : Maximum thoracic width 1 mm. Total length 23 mm, of which the branchial crown makes up 8 mm or about $^1/_3$. Nine pairs of radioles, all united by a web for $^1/_5$ of their length but without external stylodes or

eye-spots (fig. 17 A). Pinnules with slightly swollen tips, arising alternately in two rows from the inner sides of the radioles. One pair of straight narrowly pointed palps and a pair of long ventral filaments. Dorsal side of the branchial lobe with two large horny hooks, which are transparent, rounded in cross section, with a broad extension embedded in the branchial lobe. Two collars: the anterior one with dorsal lappets extending over the tips of the branchial hooks, the posterior collar with ventral lappets reflected back and overlapping a reddish ventral gland. Dorsal lappets of both collars widely separated, exposing the dorsal groove. Eight thoracic setigers; 1st setiger on the posterior collar, bearing winged capillaries only (fig. 17 B). Notosetae of setigers 2 - 8 with winged capillaries and two rows of teaspoon-shaped paleae (fig. 17 C). Thoracic neuropodia with a row of pick-axe setae (fig. 17 D), preceding a row of avicular uncini (fig. 17 F). Abdomen of 74 setigers each with a row of small avicular uncini (fig. 17 E) in the notopodia and a bundle of neurosetae. Neuropodial bundles each with 1 - 2 long and narrow winged capillaries (fig. 17 G) and 2 - 3 pick-axe setae with a rounded cap and a narrow tip (fig. 17 H). Pygidium unknown. Tube fibrous and smooth, without external coat of foreign particles.

R e m a r k s : The new genus is distinguished by its dorsally projecting horny hooks. These remarkable hooks are unique among the Sabellidae and due to their location

FIGURE 17: Cornipotamiles israeli n.sp.

(B) Winged capillaries from setiger 1.

(C) Winged capillary and palea from posterior thorax.

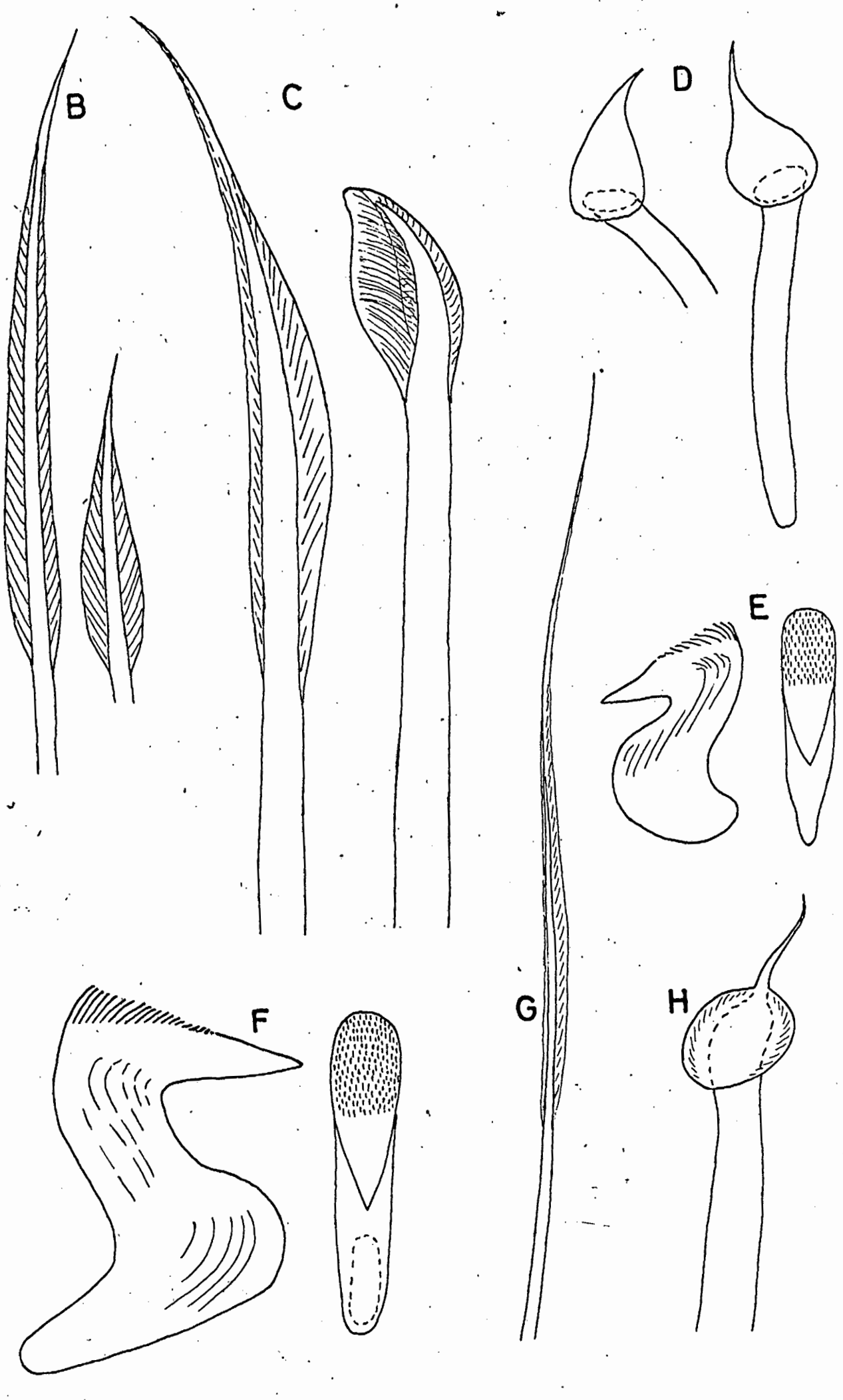
(D) Pick-axe setae from thoracic neuropodium.

(E) Profile and edge-on view of avincular uncinus from abdominal notopodium.

(F) Profile and edge-on view of avincular uncinus from thoracic neuropodium.

(G) Winged capillary from abdominal neuropodium.

(H) Pick-axe setae from abdominal neuropodium.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are not considered to be homologous with ordinary setae.

The presence of two kinds of thoracic neurosetae place this genus among the Sabellinae (Rioja 1923). It should be noted however, that in Cornipotamiles the abdominal neurosetae include both narrow-winged capillaries and pick-axe setae.

Fabriciinae Rioja

Chone Kröyer, 1856

Chone eliasonii sp.nov.

(fig. 18 A-F)

R e c o r d s : Elat, 94 m (1 spec.) - 13.7.1967.

M a t e r i a l : Holotype will be deposited in the U.S.N.M.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), on fine sand sediments.

D e s c r i p t i o n : Maximum width 0.7 mm. Length 15 mm of which the branchial crown makes up $^1/_3$. Two branchial lobes, each bearing a ventral free (?) radiole with narrow membranous flanges and seven radioles with pinnules, all united by a web for half their length and thereafter flanged as far as the tips of the pinnules (fig. 18 A). Base of branchial lobes with a circular collar-like flange, which, like the true collar is

FIGURE 18: Cone eliasonii n.sp.

(A) Lateral view of anterior end.

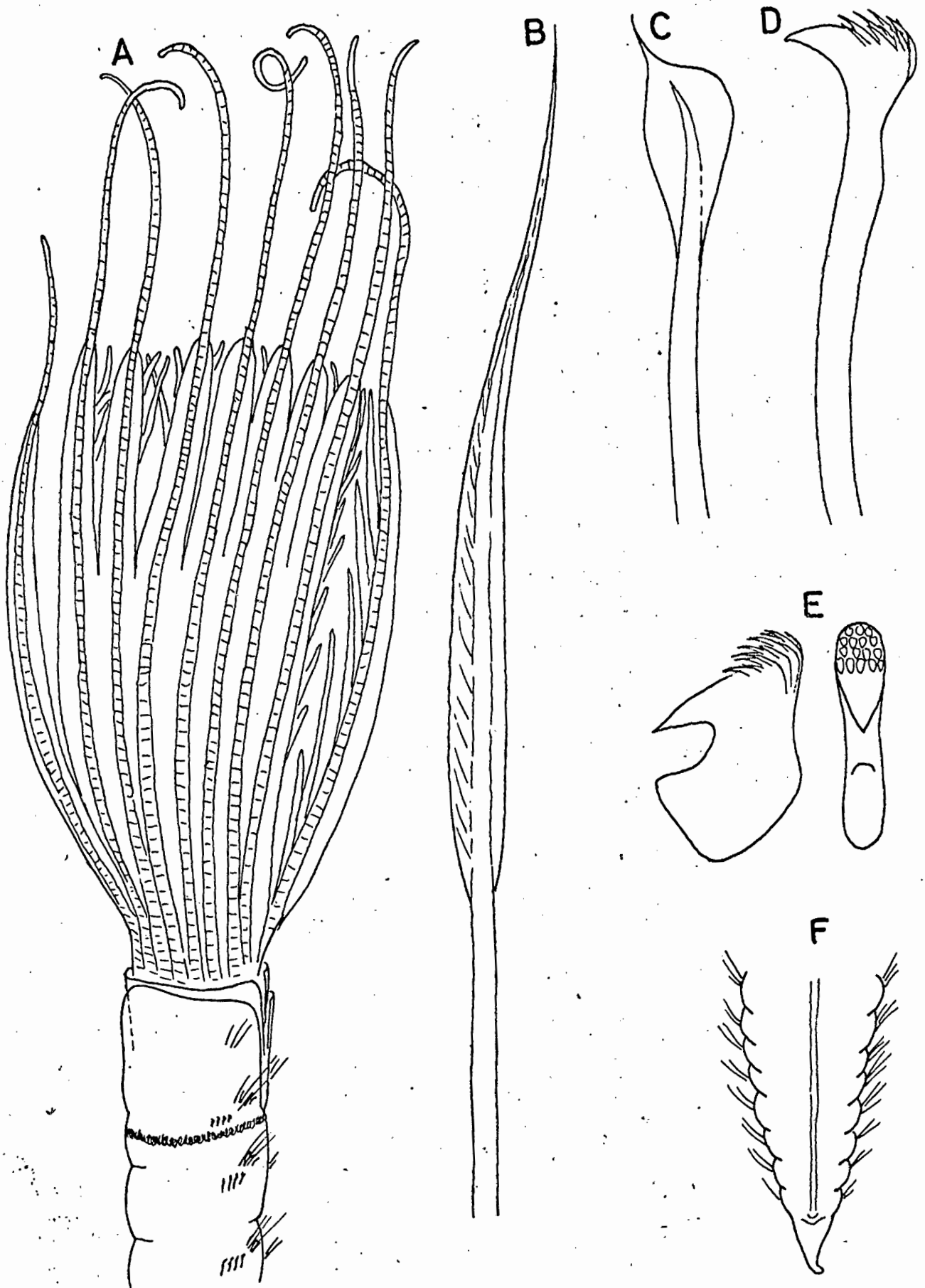
(B) Winged capillary from 1st setiger.

(C) Thoracic palea from 6th notopodium.

(D) Long-shafted hook from thoracic neuropodium.

(E) Profile and edge-on view of uncinus from 5th abdominal notopodium.

(F) Ventral view of posterior end.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disconnected dorsally at the position of the longitudinal groove. Collar, slightly notched ventrally and bearing the 1st tuft of winged capillaries (fig. 18 B). Setigers 2 - 8 with long-shafted hooks (fig. 18 D) in the neuropodia and with an upper row of winged capillaries and a lower row of short paleae (fig. 18 C) in the notopodia. Setiger 2 with a dark postsetal belt. Abdomen of 30 segments bearing capillaries with very narrow wings and uncini which decrease in size towards the mid-dorsal line. Each uncinus (fig. 18 E) with a quadrangular hilt and four rows of teeth above the main fang. Pygidium conical, with a short posterior elongation (fig. 18 F). Tube unknown.

R e m a r k s : The new species is similar to Chone filicaudata (Southern 1914) but is distinguished by its collar-like flange of the branchial base; the possession of a single pair of non-pinnulated, flanged radioles; and by its abdominal uncini which have only four rows of teeth above the main fang, contrasting with 7 - 8 rows in the Irish species and six rows in specimens from South Africa (Day, 1967).

Euchone Malmgren, 1866

Euchone rosamaris sp.nov.

(fig. 19 A-F)

R e c o r d s : Elat, 94 m (2 spec.) - 13.7.1967.

M a t e r i a l : Holotype and paratype of an incomplete juvenile will be deposited in the U.S.N.M. and the Hebrew

University of Jerusalem.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), on fine sand sediments.

D e s c r i p t i o n : Maximum thoracic width 0.95 mm. Total length 9 mm, of which the branchial crown makes up 4 mm. Eight pairs of radioles, all united by a web for about $^{2}/_{3}$ their length and ending in long naked tips. All radioles, save one or two ventral ones, with pinnules arising alternately in two rows from their inner margins. Base of branchial lobes each with two short, free ventral filaments, two ciliated buccal lappets and a rounded branchial heart (fig. 19 D). A median lip dorsally projected above the dark mouth (fig. 19 A). Collar well developed, narrowly divided dorsally and slightly notched ventrally (fig. 19 B). Thorax of eight setigers, the 1st bearing only a tuft of notopodial winged capillaries. Setigers 2 - 8, with a row of long-shafted neuropodial hooks, each with a crescentric hood and four rows of teeth above the main fang (fig. 19 C). Notopodia bearing 2 - 3 rows of ordinary and spear-shaped winged capillaries (fig. 19 E). A dark postsetal glandular belt encircling the 2nd setigerous segment. Most segments biannulated ventrally. Annuli of abdominal segments less pronounced and intercepted by the longitudinal groove. Abdomen of 15 setigers, the last seven of which form an anal funnel with a short posterior elongation. Abdominal uncini decreasing in size toward the dorsal side. Each uncinus (fig. 19 F) with 5 - 8 rows of teeth above the main fang.

FIGURE 19: Euchone rosamaris n.sp.

(A) Lateral view of entire worm with branchial crown removed.

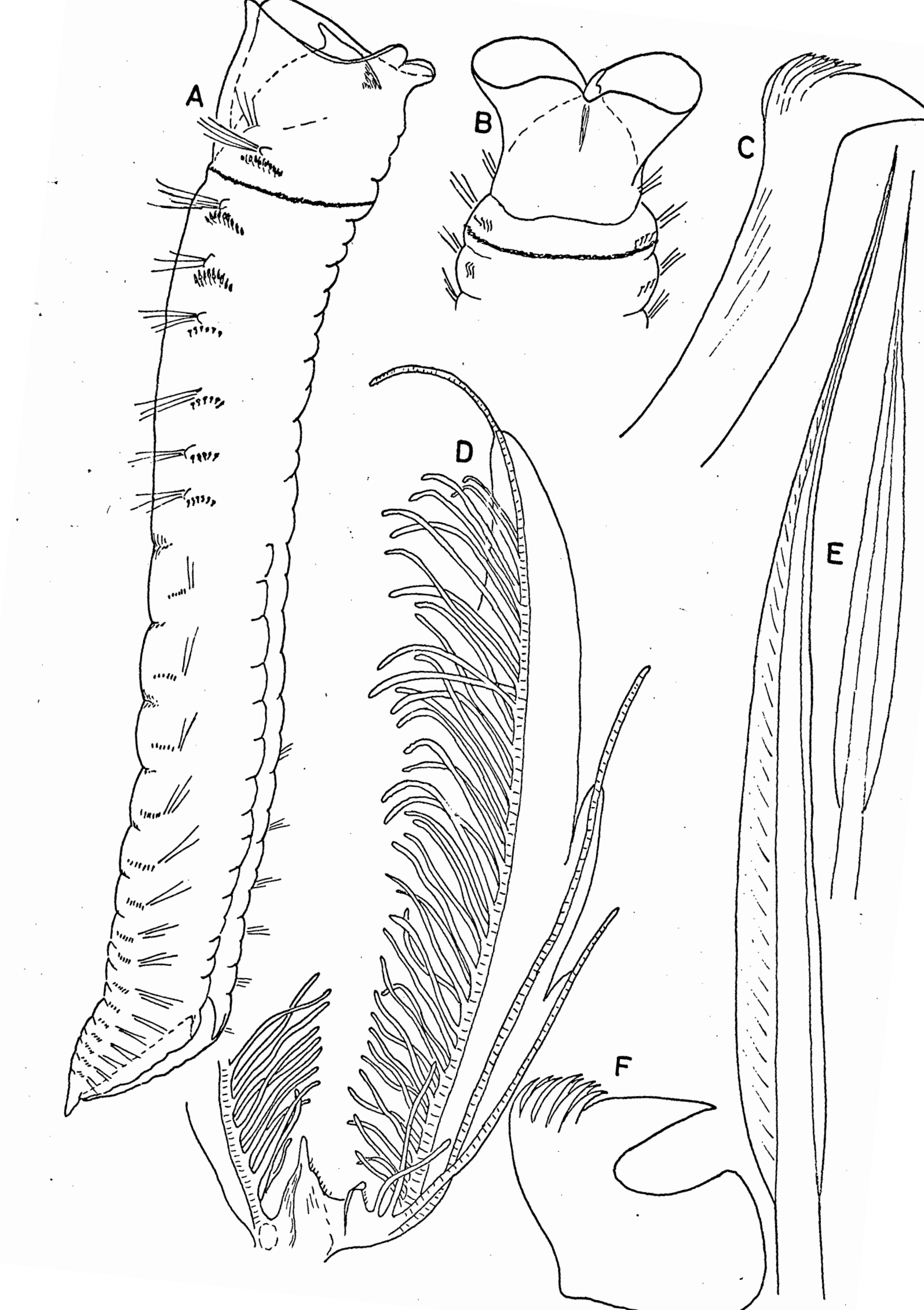
(B) Ventral view of collar.

(C) Thoracic hook from neuropodium.

(D) Branchial lobe with most radioles removed.

(E) Normal and spear-shaped winged capillaries from thoracic notopodium.

(F) Uncinus from abdominal notopodium.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The number of these teeth increases in posterior tori. Neuropodia with long delicately winged capillaries. Tubes unknown.

R e m a r k s : The new species is distinguished by its peculiar median lip and by its anal funnel which is composed of seven abdominal segments out of 15. Euchone arnae (Hartman, 1966) has an anal funnel of six setigers, whereas Euchone southerni and E. southerni incisa (Banse, 1970) have an anal funnel of four and five setigers respectively.

Euchone bansei sp.nov.

(fig. 20 A-F)

R e c o r d s : Elat, 67 m (5 specimens without branchial crowns); 94 m (3 complete spec.) - 13.7.1967.

M a t e r i a l : Holotype and paratypes will be deposited in the U.S.N.M. and the Hebrew University of Jerusalem.

T y p e - l o c a l i t y : Northern tip of the Gulf of Elat (Aqaba), in 94 m, on fine sand sediments.

D e s c r i p t i o n : Body up to 5 mm long of which the branchial crown makes up $^1/_3$. Thoracic width 0.2 mm. Two branchial lobes, each having a rounded branchial heart in its base; three radioles bearing pinnules, all united by a web for $^1/_4$ of their length; three ventral filaments and a ciliated median palp (fig. 20 A). Collar well defined,

slightly notched and projecting ventrally; disconnected dorsally, at position of the longitudinal groove. Thorax with eight ventrally annulated segments. Setiger 1 with long winged capillaries (fig. 20 C). Setigers 2 - 8 with winged capillaries and short palea (fig. 20 D) on the notopodia; long-shafted hooks on the neuropodia (fig. 20 E). A broad postsetal glandular belt on setiger 2. Abdomen of nine uncinigerous segments, with narrow winged capillaries ventrally and uncini decreasing in size towards the mid-dorsal line. Each uncinus (fig. 20 F) with 4 - 5 rows of teeth above the main fang which is relatively very small. A narrow presetal glandular belt on 3rd abdominal segment. Four last segments forming an anal funnel (fig. 20 B). Tubes unknown.

R e m a r k s : The new species resembles E. incolour, Hartman, as described by Banse (1970). It is distinguished from that species by having an anal funnel of four segments instead of three and by not having the pinnules terminate at the same level.

FIGURE 20: Euchone bansei n.sp.

(A) Lateral view of anterior end with one branchial lobe removed.

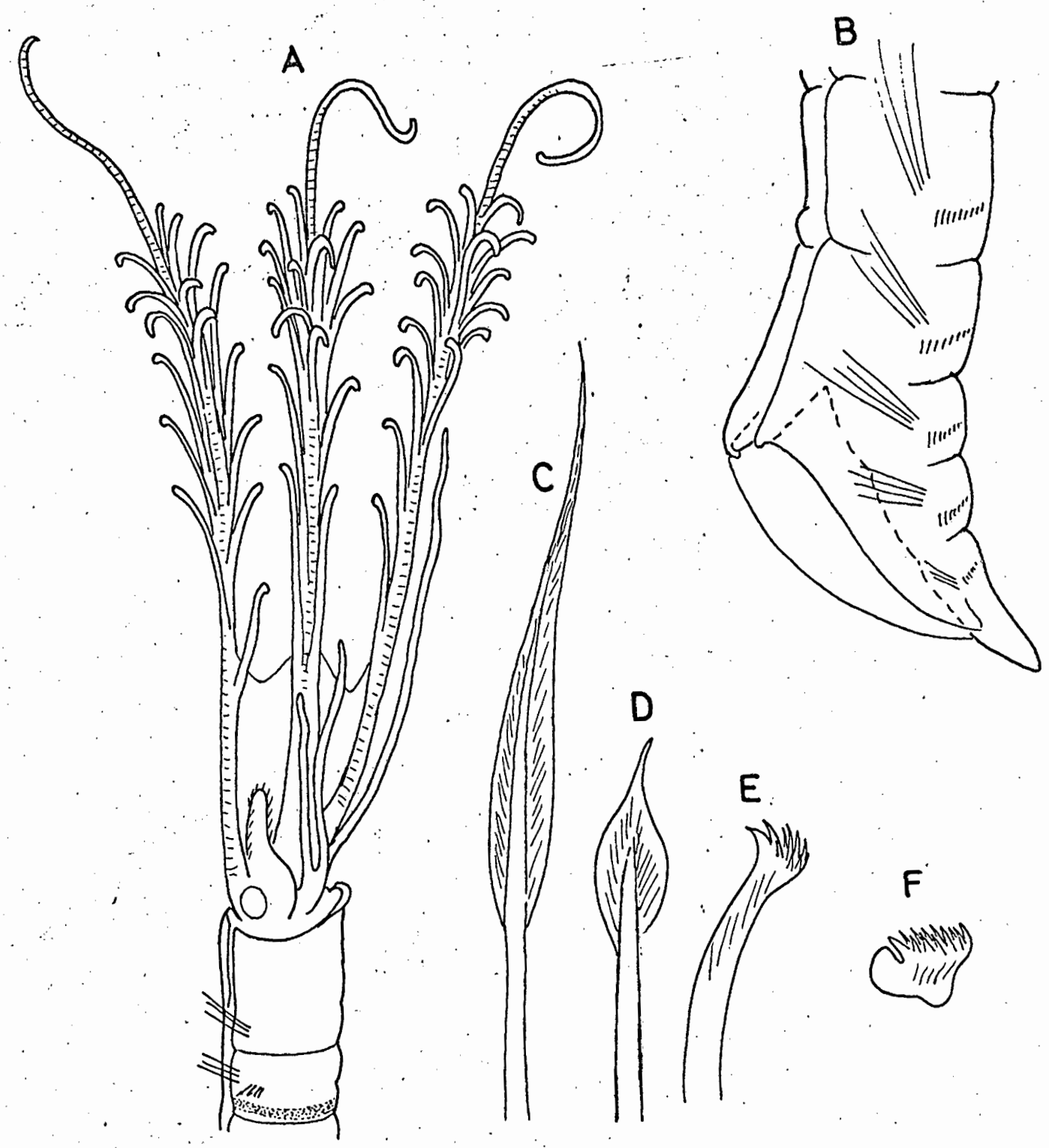
(B) Lateral view of posterior end.

(C) Thoracic winged capillary.

(D) Thoracic palae.

(E) Thoracic hook.

(F) Abdominal uncinus.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SERPULIDAE

Vermiliopsis Saint-Joseph, 1894

Vermiliopsis (? Metavermilia) zibrowii sp.nov.

(fig. 21 A-I)

R e c o r d s : Ras el Burqa, 35 m (2 spec.) - 27.9.1967.

M a t e r i a l : Holotype, paratype and several slides will be deposited in the U.S.N.M. and the Hebrew University of Jerusalem.

T y p e - l o c a l i t y : Ras el Burqa, northern part of the Gulf of Elat (Aqaba), in a dredged coral mass.

D e s c r i p t i o n : Body up to 16 mm long, of which the branchial crown makes up $^1/_4$ (fig. 21 A). Each branchial lobe with up to 16 radioles. Opercular stalk flat, wrinkled and stems dorsally from the bases of the 2nd - 4th radioles of the right branchial lobe. Operculum with a chitinised concave plate and a calcified ornamented lid (fig. 21 B) which is easily broken off. Collar well developed with three main lobes: a ventral one which is slightly notched in the middle and two lateral lobes which continue backwards as a thoracic membrane covering setiger 4. Thoracic notopodia, including the 1st tuft, with both narrow capillaries and limbate setae (fig. 21 D). Sickle setae (fig. 21 C) on setiger 2 - 7. Thoracic uncini commence on setiger 2. Each uncinus (fig. 21 E) with one row of 10 - 13 teeth behind the simple terminal gauge. Abdomen of about 40

segments with geniculated capillaries (fig. 21 F) in the neuropodia and uncini in the notopodia. Abdominal uncini (fig. 21 G) similar but much smaller than those of thorax. Abdominal uncini of anterior tori with about 10 teeth which may be single or double in the upper part of the row (fig. 21 H). Uncini of posterior tori with 1 - 3 rows of teeth and 11 - 12 teeth per row (fig. 21 I). Tubes embedded in a calcified mass, except for its anterior end.

R e m a r k s : Metavermilia Bush (1904) was emended by Zibrowius (1971) to include Vermiliopsis species with a flat, ribbon-like operular stalk which formed from the second dorsal filament of one branchial lobe. The opercular stalk of the new species seems to stem from more than one branchial filament and is wrinkled instead of ribbon-like. Apart from these differences the species conforms with Metavermilia with regard to setae, uncini and thoracic membranes. The new species is similar to M. annobonensis Zibrowius (1971) from which it is distinguished by the calcareous ornamented lid above the operculum and the thoracic uncini with twice the number of teeth.

FIGURE 21: Vermiliopsis (Metavermilia) zibrowii n.sp.

(A) Lateral view of anterior end with opercular lid removed.

(B) Anterior end of tube with opening sealed by opercular lid.

(C) Sickle seta from thoracic notopodium.

(D) Limbate and capillary setae from thoracic notopodium.

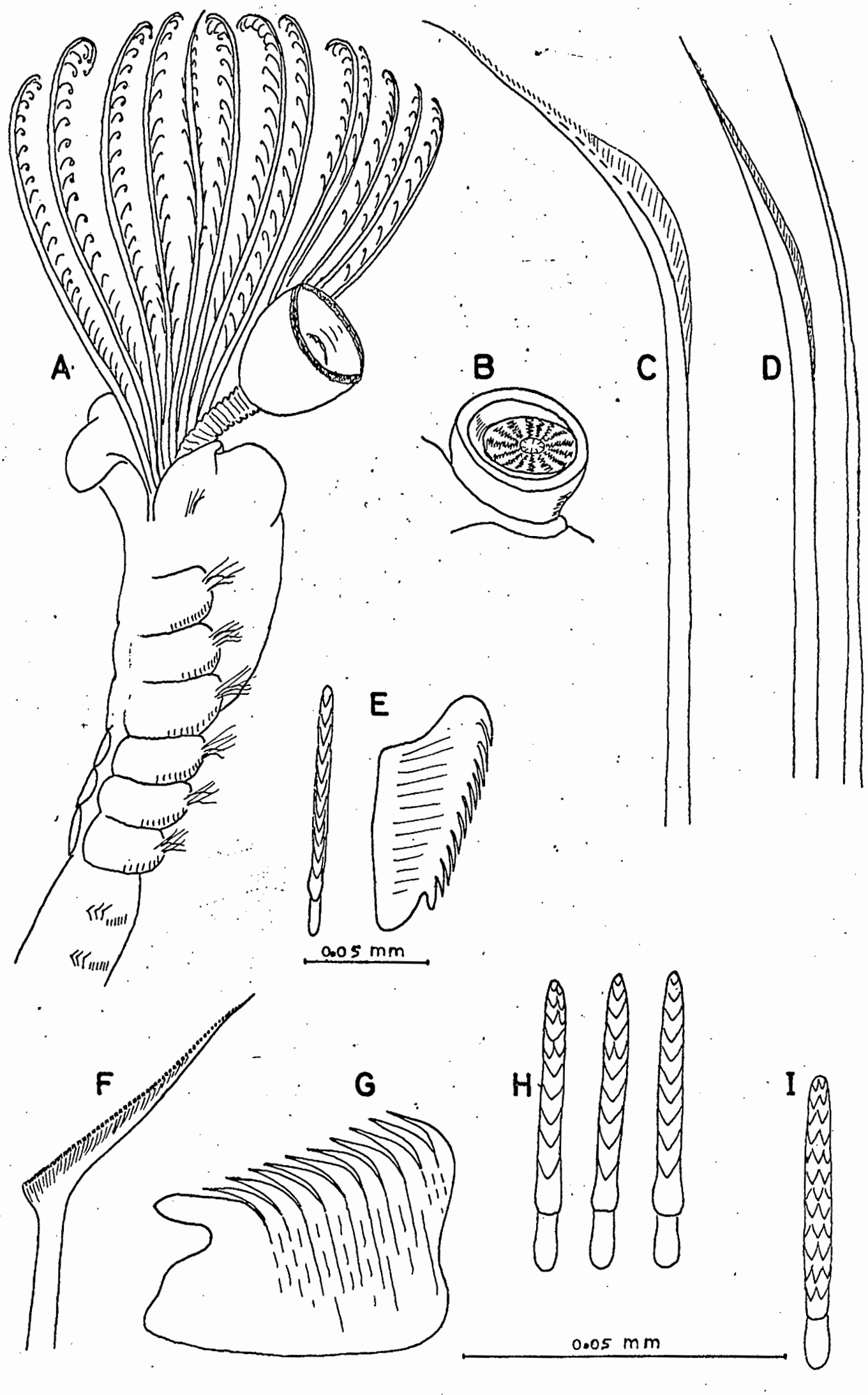
(E) Edge-on view and profile of thoracic uncinus.

(F) Geniculated capillary from abdominal neuropodium.

(G) Uncinus from abdominal notopodium.

(H) Edge-on view of abdominal uncini from anterior torus.

(I) Edge-on view of uncinus from posterior torus.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HYDROGRAPHY AND ADEPHIC FACTORS

The knowledge of the hydrography of the Gulf of Elat (Aqaba) stems from the early data collected by the "Pola" Expedition 1895-6 (Luksch, 1901). Further hydrographic studies were made by Mohamed (1940) and Deacon (1952). Oren (1962) provides most of the data for the northern part of the Gulf, which is the subject of this ecological survey. The last author, as well as Schick (1958), emphasised the importance of climatic influence, especially that of wind, on hydrological conditions.

The prevailing wind in the Gulf is northerly, with occasional northwesterly contributions. The northerly winds cause upwelling in the northern end of the Gulf but, through mixing processes, the homogeneity of the water mass is very marked. Oxygen values range between 1.5 to 4.5 ml/litre throughout the water column down to 820 m (Por et al., 1966) whereas surface values are mostly within the limits of 100% saturation (Oren, 1962). On the other hand, the values of inorganic phosphate are relatively very low at the surface and have a maximum of only 23 mg P per m^3 from 700 m downwards. This contrasts with the Red Sea proper, where the surface values are also low but with a maximum concentration of 64-69 mg P per m^3 between 400 and 600 m and with a constant concentration of 34-39 mg P per m^3 below 800 m (Mohamed, 1940).

The variation in vertical distribution of temperature

between the surface and 100 m (Oren, 1962) and between 50 and 820 m (Por et al., 1966) rarely exceeds 2° C. Between 300 and 400 m there is a layer of minimum temperature which Mohamed (1940) reported to be of 21.20° C, beneath which there is an adiabatic increase of 0.20° C for each 1000 m. However, the possibility of a contribution from warm underwater mineral springs (similar to those found in the Red Sea) should not be excluded. Furthermore, since the surface temperature varies between 27° C in summer and 20° C in winter (Oren, 1962), the deep layer of minimum temperature could be expected to vary accordingly, though to a lesser extent. The horizontal distribution of surface temperature is reported to increase from north to south (Schick, 1958; Oren, 1962) but this might easily be confused with the diurnal variation due to insolation (Deacon, 1952).

Like temperature, the vertical distribution of salinity shows considerable homogeneity. Deacon (1952) gives values of 40.78°/$_{oo}$ (0 m) and 40.66°/$_{oo}$ (820 m) whilst Por et al. (1966) give 40.62°/$_{oo}$ (50 m) and 40.78°/$_{oo}$ (820 m). These salinities are slightly higher than those of comparable depths in the Red Sea proper and lower than those of the much shallower Gulf of Suez which are over 42°/$_{oo}$ (Mohamed 1940). The high salinities of these Gulfs are mainly due to excessive evaporation. Although the rate of evaporation from the Gulf of Elat is lower than that from the Red Sea proper (Newmann, 1952), the southern part of the Red Sea is influenced by an influx of surface, low salinity waters from

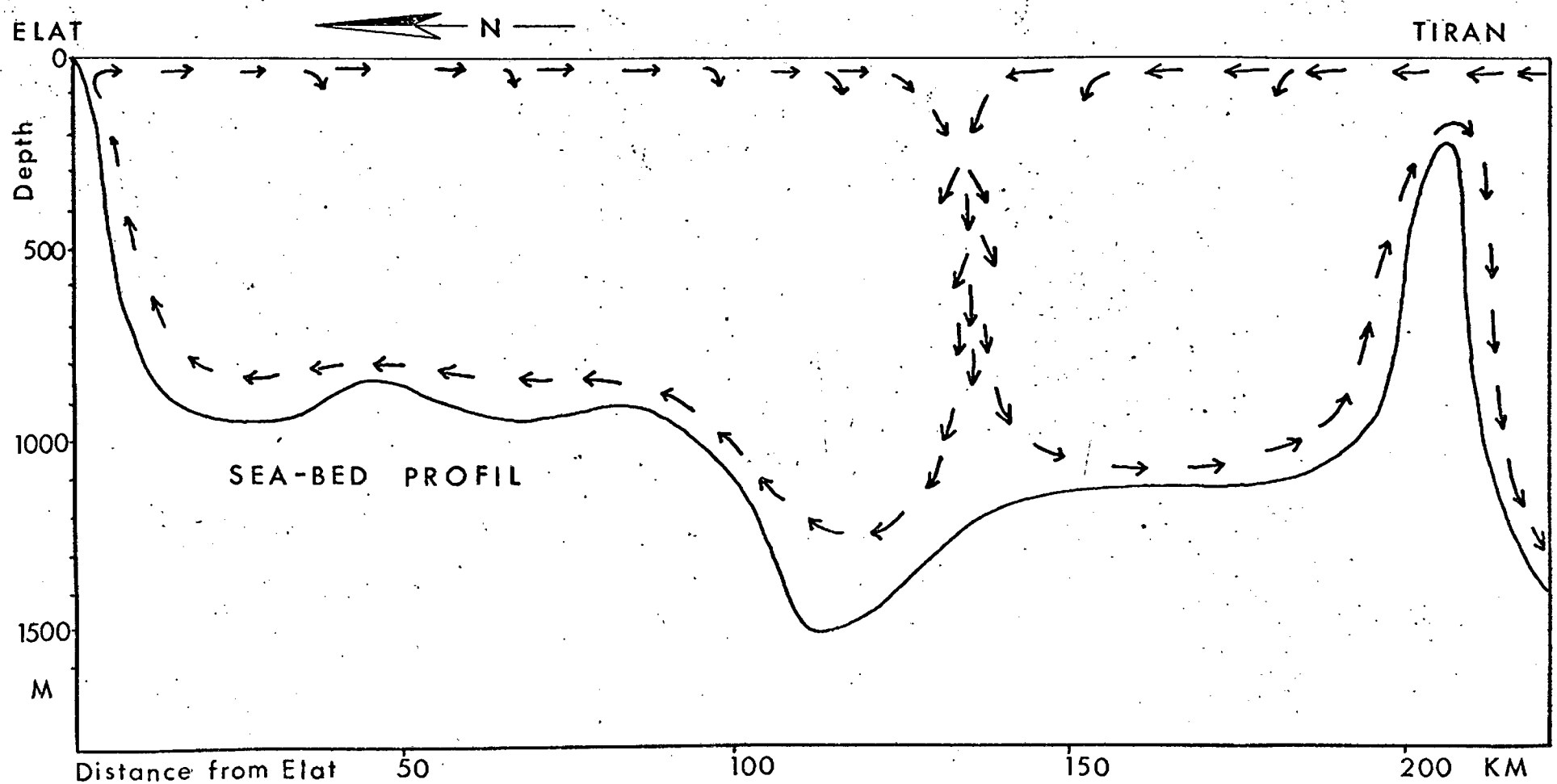
the Indian Ocean.

The confluence between the Gulf of Elat and the Red Sea, in the Straits of Tiran, is across a sill with a maximum depth of 245 to 256 m and a width of 1 km for depths greater than 100 m. The exchange of water over this sill is quite limited: there is a sporadic northward flowing surface current with a velocity of up to 1.5 knots (British Admiralty Chart - 3595, 1971) and a southward flowing saline current beneath (Mohamed, 1940). This manner of water exchange is typical of a strait between two water masses of different salinities, such as the Straits of Gibraltar. However, the exchange over the sill of Tiran is much more limited, particularly since the northward flowing surface current is hampered by the prevailing northerly wind.

After entering the Gulf of Elat, Red Sea surface water can be detected on the eastern side for about half the length of the Gulf (Deacon, 1952). Since, in the northern part, there is a southerly wind-driven surface current there should be a zone of convergence (and sinking) on a hypothetical line obliquely across the Gulf between Bir el Mashi in the East and a point on the western bank between Dahab and Marsa Abu Zbad (for locations see fig. 1).

Thus the northern part of the Gulf of Elat could represent a fairly closed system between the upwelling zone at the head and the convergence zone in the middle. A proposed scheme of water movements is shown in fig. 22.

FIGURE 22: Proposed scheme of water movement along a north-south axis in the Gulf of Elat.


ELAT
N
TIRAN
0
Depth
500
1000
1500
M
SEA-BED PROFIL
Distance from Elat
50
100
150
200
KM

The northern part of the Gulf is therefore even more isolated from the Red Sea than the southern part, and this may be an important factor in the evolution of an endemic fauna.

The sediments of the Southern part of the Gulf of Elat were studied by Shukri and Higazy (1944 , 1944a) and Mohamed (1949), whereas those of the northern tip were studied by Emery (1964). The latter author pointed out that the sediments of the Gulf have an exceptionally low nitrogen and organic carbon content. This, it was suggested, is a result of the low organic production, already indicated by the low phosphate values. Also, the low organic carbon values could be influenced by the presence of well oxygenated bottom water which causes much of the deposited organic material to be decomposed.

Sediment samples (Table II) were collected along the ecological transect which was discussed by Por et al. (1966). The results of the granulometric analyses are plotted together with an underwater morphological profile (fig. 23) which runs along the centre of the Gulf, from the northern tip down to a depth of 550 m. The profile is along a continuation of the Arava Valley, which is the main source of terrigenous material that reaches this part of the Gulf during occasional flash floods. Run-off may reach the coast during winter and early spring, and this may be the reason for the absence of a fringing coral reef along the northern coast (Por et al., 1966). On the other hand, the

TABLE II

LIST OF SEDIMENT SAMPLES AND THE PERCENTAGE OF THEIR GRANULAMETRIC COMPOSITION

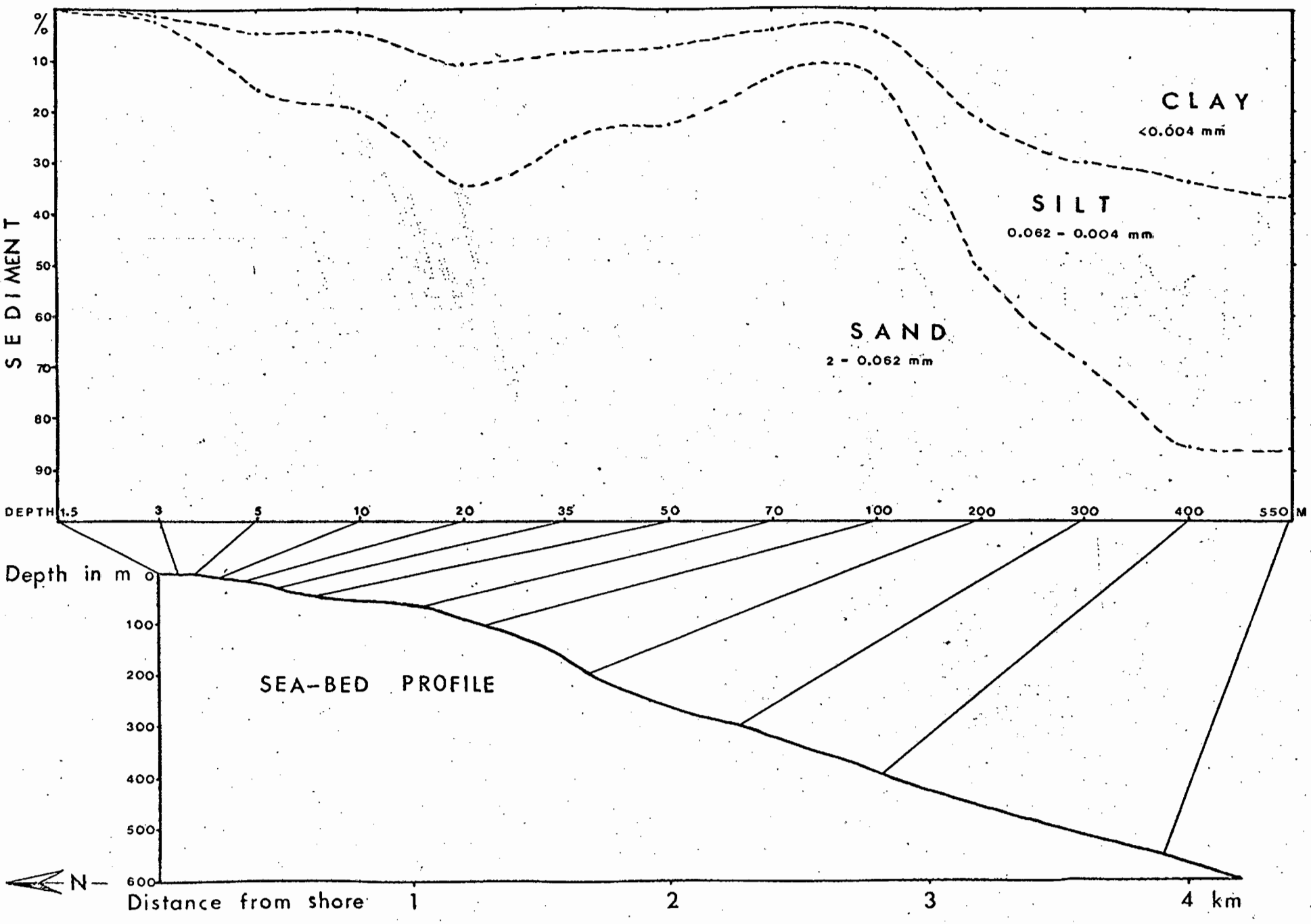
Depth in m	Date	Sample No.	Sand 2 mm - 62 µ	Silt 62 - 4 µ	Clay < 4 µ
1.5	19. 9.65	RS-22	98.16	0.54	1.30
3	"	RS-25	97.64	1.14	1.21
5	"	RS-24	84.62	10.60	4.76
10	"	RS-23	80.66	14.13	4.00
20	"	RS-26	65.50	24.19	10.19
35	8.10.65	RS-13	74.01	17.81	8.18
50	"	RS-14	77.19	15.46	7.33
70	"	RS-15	86.56	8.07	4.21
95	"	RS-16	86.41	8.66	4.92
190	"	RS-18	49.65	28.31	22.04
300	20. 8.65	RS-4	31.37	39.58	29.05
400	"	RS-9	14.16	52.18	33.64
550	"	RS-5	14.54	49.25	36.20

amount of detritus which reaches the gulf during these occasions must be quite limited, since the transparency of the water up to 40 m is exceptionally high.

Between the depths of 1.5 and 20 m there is a classical sorting of sediments, whereby the finer particles are to be found further away from the input area. The colour of these sediments is light brown close to the beach, becoming dark brown between 20 and 100 m. Within the latter depth range the sedimentological graph shows that there is an apparent anomaly, since the percentage of sand is increasing

with depth instead of decreasing away from the source point. Emery (1964) explains this anomaly by the presence of coarse grain organic sediments diluting the fine grain terrigenous sediments between about 50 m and greater than 100 m. These coarse grain sediments are composed of the tests of foraminifers and the shells of gastropods and pelecypods. The graph also shows that the presence of such organic sediments is actually noticeable at 20 to 35 m. This may confirm the observations of Said (1950) who found in the northern part of the open Red Sea that a lower Foramenifera community commences at 21 m. Furthermore, gastropod shells were found down to 270 m and especially at 200 m. At the latter depth the sediment is bright yellow and has an obvious organic origin. The yellow colour of the sediments could be detected from 120-150 m, where the sediment is extremely compact, and down to 500 m. From this level down the sediment is a dark mud, composed of pteropod ooze.

FIGURE 23: Sediment and sea-bed profiles of the northern tip of the Gulf of Elat.


%
10
20
30
40
50
60
70
80
90
SEDIMENT
CLAY
<0.004 mm
SILT
0.062 - 0.004 mm
SAND
2 - 0.062 mm
DEPTH 1.5 3 5 10 20 35 50 70 100 200 300 400 550 M
Depth in m
0
100
200
300
400
500
600
SEA-BED PROFILE
N
Distance from shore 1 2 3 4 km

POLYCHAETE DISTRIBUTION AND THE MAIN BENTHIC ASSOCIATIONS

Like the rest of the samples, those of the ecological profile (Table III) were separated into families and the frequency of specimen occurrence was registered according to a frequency code, which has been discussed earlier in the chapter on materials and methods. These code numbers are shown in Table III between columns 7 to 17 for the 10 larger families, whereas the sum of specimen frequencies of all families in a given sample is shown in the 6th column. This method of registering specimens discriminates against the larger families, because a small family represented by less than 10 specimens would be registered as 1 or 2 whereas a large family represented by dozens of specimens will still only be recorded as 5.

The samples were collected with different equipment and only those from the grab may be considered quantitative. However, even samples collected with a grab were not always quantitative. Sometimes the grab was not locked properly and part of the sample was washed away before reaching the working deck. Occasionally the sea bottom was too hard to allow complete penetration of the grab's blades, resulting in a reduced sample. Even the sledge may have landed a poor sample, if it bounced along the bottom instead of actively scraping. A clear indication of under-representation of a sample is shown when the sum of specimen frequencies equals the number of families.

TABLE III

POLYCHAETE SAMPLES ALONG THE ECOLOGICAL PROFILE AND THE CODED FREQUENCY OF THE LARGEST FAMILIES

Depth in m	Date	Sampling No.	Sampling Gear	Families Number	Sum of Specimen Frequencies	LARGEST FAMILIES REGISTERED ACCORDING TO A FREQUENCY CODE*									
						Syllidae	Capitellidae	Nephtyidae	Paraonidae	Lumbrineridae	Spionidae	Glyceridae	Sabellidae	Ophelliidae	Cirratalidae
0.5	16. 6.66	RS -43	Hand net	3	3	1	1	-	-	-	-	-	-	-	-
1.5	13. 7.67	SLR-225	Grab	19	14	1	-	1	-	-	-	3	3	-	-
2.5	16. 3.66	RS -42	Hand net	4	4	1	1	-	1	-	-	1	-	-	-
3	13. 7.67	SLR-228	Grab	15	21	3	2	2	1	-	-	1	1	2	1
3	8.11.65	RS -25	"	10	18	3	1	2	3	-	-	1	-	4	-
5	13. 7.67	SLR-227	"	8	17	4	1	2	-	-	-	2	-	5	-
7	16. 2.67	RS -90	Sledge	14	24	5	2	1	1	3	-	1	1	-	2
10	13. 7.67	SLR-229	Grab	16	25	3	2	3	2	-	-	1	1	3	1
15	8.10.65	RS -12	"	16	38	4	3	5	2	3	3	1	-	4	-
20	13. 7.67	SLR-230	"	14	24	3	2	4	2	3	1	1	1	1	1
35	"	SLR-231	"	15	22	2	1	4	2	2	-	1	1	2	1
42	3. 1.67	RS -82	"	3	3	1	-	1	-	-	-	-	-	-	-
48	13. 7.67	SLR-232	"	14	26	5	1	2	2	2	3	-	1	-	3
60	16. 2.67	RS -98	Sledge	8	15	4	-	2	1	3	-	-	1	-	-
67	13. 7.67	SLR-233	Grab	17	23	3	2	1	1	2	2	1	1	1	-
70	16. 6.67	RS -31	"	13	21	2	1	1	3	1	5	1	1	-	-

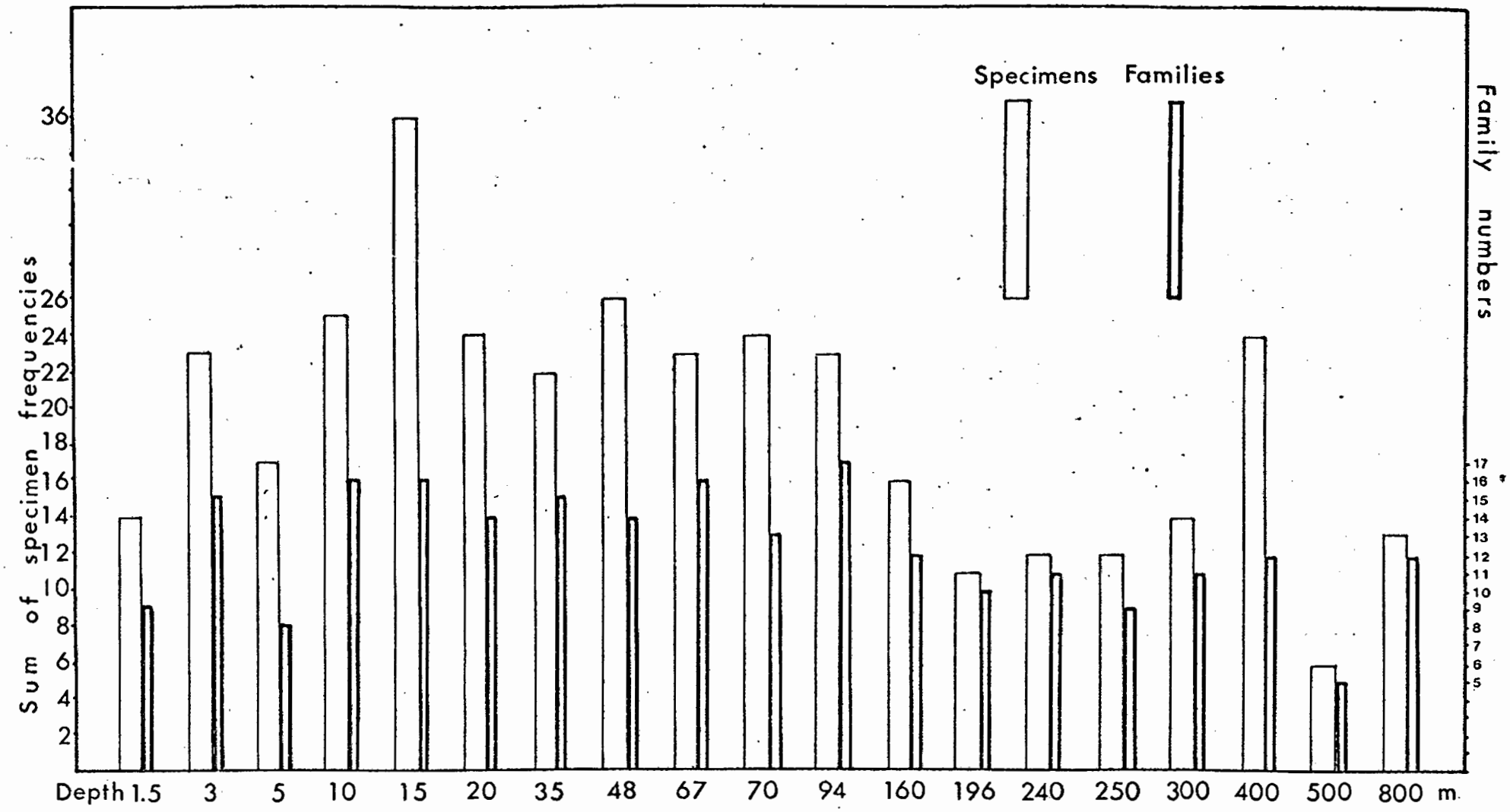
80-50	13. 3.66	RS -38	Sledge	2	4	3	-	-	-	-	-	-	-	-	-
94	13. 7.67	SLR-234	Grab	17	23	3	2	1	1	1	2	1	2	1	1
120	28.11.66	RS -72	"	2	2	-	-	-	-	1	-	-	-	-	-
140	13. 3.66	RS -35	"	8	8	1	-	-	1	1	1	1	-	-	-
155	28.11.66	RS -73	"	9	9	1	-	-	1	1	-	-	1	-	1
160	13. 3.66	RS -36	"	12	16	3	1	-	3	1	-	1	1	1	1
196	16. 6.66	RS -52	"	10	11	1	1	1	2	1	1	-	-	-	-
200	13. 7.67	SLR-235	"	7	7	-	1	-	1	-	-	-	-	-	-
200	16. 2.67	RS -103	Sledge	12	20	5	1	1	3	2	-	1	-	-	-
240	28.11.66	RS -69	Grab	11	12	1	1	1	2	-	-	-	1	-	1
250	16. 6.66	RS -55	"	9	12	2	1	1	1	1	2	1	-	-	1
270	16. 2.67	RS -105	Sledge	13	25	3	3	2	1	5	1	1	-	-	-
300	13. 7.67	SLR-236	Grab	11	14	1	2	1	2	1	2	-	-	-	1
400	"	SLR-237	"	13	24	1	5	1	1	3	3	1	-	-	3
500	2. 1.66	RS -28	"	4	5	-	2	1	-	-	1	-	-	-	-
550	13. 7.67	SLR-238	"	6	6	1	1	-	-	-	1	1	-	-	-
800	27. 9.67	SLR-822	"	12	13	2	1	-	1	1	1	1	-	-	-

* Frequency code: 1 - present, 1-4 specimens;
2 - fairly common, 5-10 specimens;
3 - common, 11-25 specimens;
4 - very common, 25-40 specimens;
5 - abundant, > 40 specimens.

In order to deal with comparable samples, all the non-quantitative samples have been omitted from the ecological histogram (fig. 24). Samples from 196, 240, 500 and 800 m, although under-represented, were nevertheless reluctantly included, as there were no other reliable samples from these areas. On the other hand, if more than one sample was collected from the same depth, the one with most families was considered for comparison. Having a high sum of specimen frequencies, the sample from 15 m was considered an exception, even though it was collected from one of the richest areas. Since the number of families and their composition was similar to those of neighbouring samples, it was assumed that this sample is actually composed of the contents of two grab samples which were mistakenly combined. There is a possibility that its apparent abundance may be real and due to some factor which cannot be determined from the available data.

Samples from 5 and 48 m contained a large number of Opheliidae and Syllidae specimens respectively, which were not apparent from their registration by the frequency code, for the reasons stated above. This is partly corrected if one considers the distribution of the 10 leading families along the ecological profile (fig. 25). Those 10 families are the most common in all the samples and only in samples which are grossly over-represented (such as long dredge haul) do families such as Amphinomidae in 200 m and Palmyridae in 7 and 15 m become represented by a frequency code of 3 (common). Altogether, 41 families were observed along the

FIGURE 24: Histogram of sums of specimen frequencies (according to code) and family abundance along the ecological profile.


Specimens
Families
Sum of specimen frequencies
Family numbers
36
26
24
22
20
18
16
14
12
10
8
6
4
2
17
16
15
14
13
12
11
10
9
8
7
6
5
Depth 1.5
3
5
10
15
20
35
48
67
70
94
160
196
240
250
300
400
500
800
m

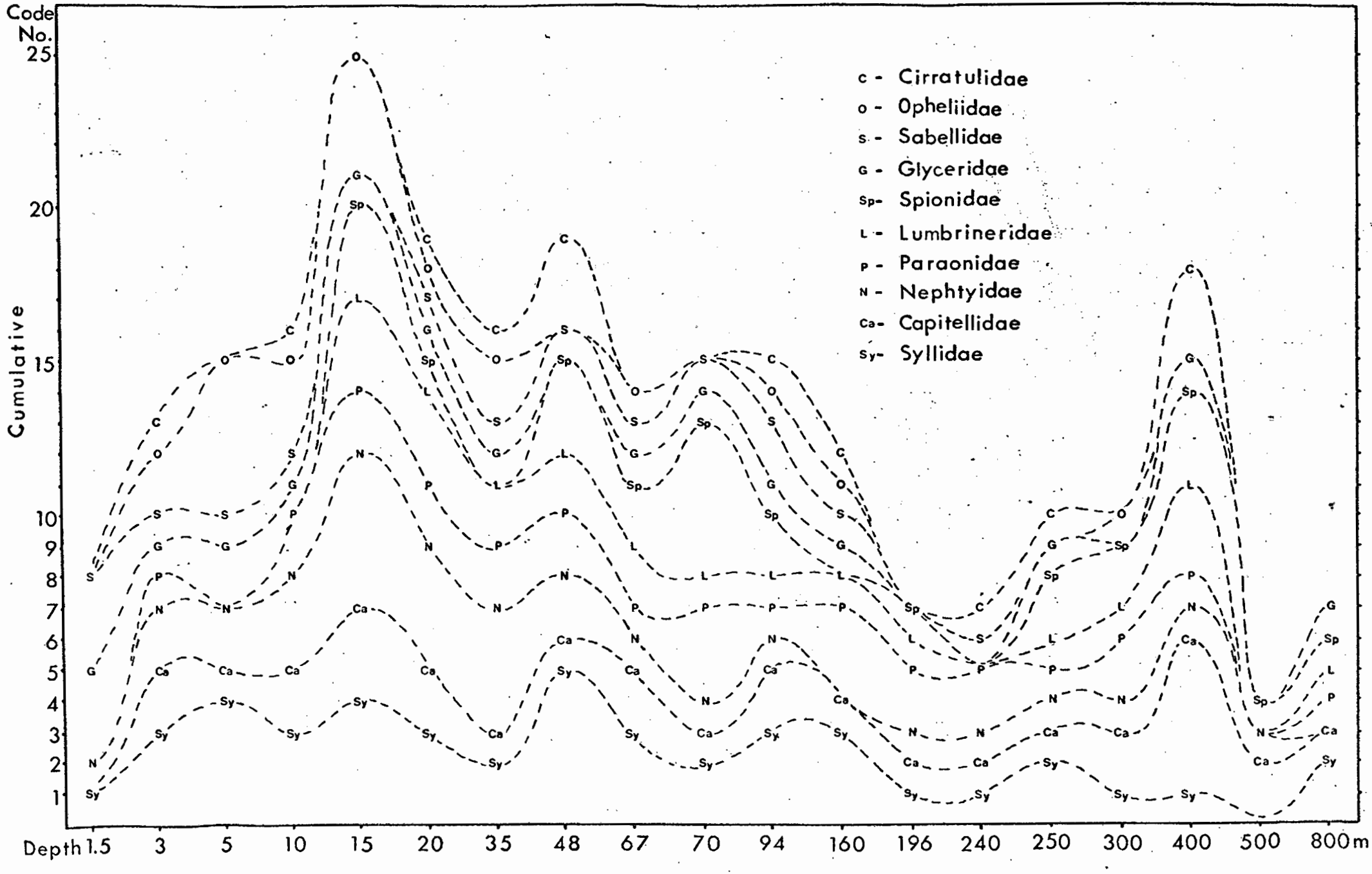
profile and most of them have not been recorded for the Gulf of Elat.

Taking into consideration all those samples which are under or over-represented as well as the sledge samples from 7, 200 and 270 m, it is possible to divide the distribution of the polychaetes along the profile into six consecutive faunal zones. These were found to be in accordance with the main benthic associations preliminarily described by Por et al. (1966). The latter author found seven faunal zones, but in the one sample reported here from his first zone (the Hippa community) which includes the interstitial fauna, the polychaete fauna were very poorly represented and thus this zone is being ignored in the present study.

A. The coastal zone up to about 4 m depth, known as "the Lovenia-Mactra community" in Por's classification, is characterised by an increase of fauna with increasing depth. The commonly represented families are the Sabellidae, Glyceridae and Syllidae. According to Por et al. (1966) the meiofauna is rich, mainly in Hydracarina and harpacticoids, and also in amphipods, tanaidaceans and ostracods.

B. The vegetation zone is composed of the compact Halophila meadows, up to about 40 m. This zone is rich in detritus and the polychaete fauna is abundantly represented by Opheliidae and Nephtyidae, while the syllids are very common and the lumbrinerids are common as well.

The meiofauna is very rich in sipunculoids, halacarids


Code No.
Cumulative
Depth
1.5
3
5
10
15
20
35
48
67
70
94
160
196
240
250
300
400
500
800m
C - Cirratulidae
O - Opheliidae
S - Sabellidae
G - Glyceridae
Sp - Spionidae
L - Lumbrineridae
P - Paraonidae
N - Nephtyidae
Ca - Capitellidae
Sy - Syllidae

and tanaidaceans. Ophiuroids, ostracods and nematodes are also well represented in addition to a restricted number of amphipods, cumaceans and harpacticoids (Por et al., 1966).

C. The Foraminifera zone down to 100 m and more is also rich in polychaetes like the previous zone, but the dominance of Opheliidae and Nephtyidae is replaced by that of Syllidae and Spionidae. The Paraonidae and Cirratulidae are also common.

The meiofauna is especially rich in ophiuroids, tanaidaceans and halacarids. Sipunculoids are still numerous and amphipods, nematodes and harpacticoids are present, whereas ostracods are relatively scarce (Por et al., 1966).

According to the latter author, this area is poor in polychaetes, which is contrary to present evidence. However, since Por's observations are relative to other fauna, and the present work shows that polychaetes are abundant (figs. 24 and 25), it follows that the entire fauna of this area must be among the richest section of the profile.

D. The Turritella community from below the depth of 100 m to about 260 m is on yellow compact sediment with many gastropods, after which this community is named. The common polychaete families are Paraonidae and Syllidae.

The meiofauna is rich in halacarids and harpacticoids, but poor in amphipods, tanaidaceans and ostracods. Sipunculoids and cumaceans are also less frequent (Por et al., 1966).

According to the latter author, the polychaete fauna is "amazingly rich" but this is not confirmed in the present study. On the contrary, relative to other areas the polychaetes are less abundant, and this implies that the overall fauna of the zone is even poorer.

E. The area between 260 and 470 m is rich in polychaetes and the family Capitellidae is abundant. Also the Lumbrineridae, Spionidae and Cirratulidae are common. Por et al. (1966) named this the Palaeostoma-Hyalinoecia zone, the second name being that of the Onuphidae polychaete Hyalinoecia tubicola. However, only one specimen of what seemed to be Hyalinoecia tubicola was identified from this area. Most of the empty tubes found in the present work were those of Chaetopteridae, Spiochaetopterus sp., probably Spiochaetopterus costarum rubra (subsp. nov.). According to Por et al. (1966) the meiofauna seems to be essentially the same as in the shallow community with the additional appearance of anthurid isopods.

F. The deepest zone, the Pteropode ooze community, is represented in this collection by only three samples, all of them apparently under-represented. Capitellidae and Syllidae are fairly common and the presence of 12 families from a depth of 800 m indicates that this zone is probably richer than it looks.

DISCUSSION AND CONCLUSIONS

1. The ecological survey along the northern profile confirms six of the seven zones of benthic associations identified by Por et al. (1966). These zones are more clearly recognised in shallow waters (e.g. Halophila meadows and Foraminifera bottoms) although sediment analyses (fig. 23) and the pattern of distribution of the polychaete families (fig. 25) indicate a certain degree of overlapping. The borders between the zones in deep waters are still to be defined. Likewise, the factors affecting the abundance of fauna in the respective zones are still to be explained. Answers to these questions may be provided upon the completion of the taxonomic studies of the various groups, including Polychaeta, and by collecting and examining more material.

2. The specimens from the bottom of the gulf are surprisingly minute, even though, as tropical fauna, they might be expected to be small in comparison with specimens from temperate regions (Moore, 1958). Unless a net with a mesh size of 250 μ is used, a great proportion of the polychaetes from this area would be lost in the sieving process. This, perhaps, is the reason why only a single new species was described by Fishelson and Rulier (1969). It is believed that a much greater proportion of small specimens than is usually recorded does exist among the fauna elsewhere, and the suggested handling techniques might be useful in their study.

3. The great taxonomic divergence of the fauna is due to the tropical conditions already mentioned, and the high number of new species is not surprising, in view of the limited number of studies from the Gulf in general, and from its deep water in particular. Most of the recorded species of the Red Sea belong to the Indo-West Pacific region, but a great number are cosmopolitan (Fauvel, 1953, 1957, 1958). With the increasing use of big oil tankers which transfer sea water as ballast from all over the world, more cosmopolitan species are expected to be found in areas such as the Gulf and the Red Sea which contain a very heavy tanker traffic. Correspondingly, increasing numbers of endemic species can expect to be transferred to other areas.

4. The discovery of such aberrant genera as Dayius (Pilargidae), Aqabana (Ampharetidae) and Cornipotamiles (Sabellidae), indicates the existence of substantial endemism in the Gulf. Factors which enable the evolution of an endemic fauna in the Gulf are: (a) the narrow sill in the Straits of Tiran, which separates the Gulf of Elat from the Red Sea proper; (b) the presence of well oxygenated deep water, and (c) a possible zone of convergence in the middle of the Gulf which separates, to an as yet unknown degree, the northern and southern parts of the Gulf.

5. Due to the arid climate of the region and the northerly prevailing winds the Gulf has a very limited fresh water run-off, a high salinity, high temperature, considerable vertical homogeneity and low values of phosphate and nitrate.

6. The high transparency of the water is an indication not only of a low level of detritus, but also of an impoverished plankton. Although no data on primary production is available, the poor biomass of macroalgae, together with the low level of dissolved phosphate suggest that the level of primary production is quite low.

7. Since Polychaeta is an important benthic group, its impoverished biomass in an upwelling area must indicate a low productivity not only of the benthic fauna, but of the entire Gulf. The exceptions are possibly the coral reef communities which to a great extent are independent and isolated from the biological processes elsewhere. However, the fringing coral reef occupies only a relatively narrow strip along the coast and it is not known to what extent, if at all, it influences the productivity of the entire Gulf.

8. Odum and Odum (1955) show that in a tropical reef there could be a high level of productivity in spite of observed low levels of nitrogen and phosphate. This is due to a large biomass which rapidly incorporates these nutrients as they are released into the environment from large reserves of decomposing organic matter. In the Gulf of Elat, as it was pointed out by Emery (1964) there is little organic matter in the sediments and if in addition there is a deficiency in basic chemical elements and the living biomass is found to be poor, it must be assumed that the lack of nutrients inhibits the productivity of the Gulf.

9. One practical conclusion emerges from this study, namely, since the productivity and standing crop of the Gulf is low, no substantial fishing industry could be established unless enrichment techniques of pond culture are applied.

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SARSIA **37**: 9–20

A CONTRIBUTION TO THE REVISION OF *SPIOCHAETOPTERUS* (CHAETOPTERIDAE, POLYCHAETA)[1]

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ABSTRACT

A new species, *Spiochaetopterus bergensis*, from Western Norway is described, and a revision of the entire genus revealed that the species originally known as *Telepsavus costarum*, *Spiochaetopterus oculatus*, and *Leptochaetopterus pottsi* need to be reclassified. The status of some species was found to be questionable, while others were rediagnosed. Keys for the valid genera and species are given and the involved taxonomic problems are discussed.

INTRODUCTION

Chaetopterids are tubicolous worms which easily break into fragments and are difficult to preserve satisfactorily. Thus a number of species have been poorly described, many names were found to be synonymous (HARTMAN 1959), and most of the genera had to be redefined (POTTS 1914; FAUVEL 1927; DAY 1967).

Spiochaetopterus was erected by SARS (1853) on the basis of a specimen found in western Norway. Discovering a new species from the same area and comparing it with related species, I realised that the entire genus needed revision. This is probably true also of the other genera in the family.

My study was based on material from the Biological Station of the University of Bergen, the Bergen Zoological Museum and on some specimens from the natural history museums of London, Paris, Washington, Stockholm, Copenhagen, Oslo and the University of Cape Town.

DESCRIPTIONS

Key to genera

1. One pair of head appendages (palps) 2
— Two pairs of head appendages: one pair of long palps and a pair of tentacular cirri situated posterior to the palps. Notopodia of the middle region foliaceous, bilobed or multilobed. Tube semitransparent and often branched ..... *Phyllochaetopterus*

2. Palps longer than the anterior region. Notopodia of the middle region unilobed, bilobed or trilobed, but never fused across the dorsum 3

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— Palps shorter than the anterior region. Middle region of 5 segments, the first of which bears a pair of separate, wing-like notopodia, while most of the other segments have their notopodia fused to form paddles. Peristomium forming a broad collar. Tube usually broad, U-shaped and covered with sand grains ..... *Chaetopterus*

3. Middle region (not sharply marked off from the posterior region) of less than 5 segments bearing unilobed, conical, fleshy or finger-like notopodia. Setiger 4 with a number of stout modified setae. Tube straight or twisted, usually covered with sand or shell fragments ..... *Mesochaetopterus*
— Middle region of variable number of segments bearing bilobed or trilobed notopodia. Setiger 4 usually with one stout modified seta. Tube distinctly annulated, semitransparent, straight or twisted ..... *Spiochaetopterus*

Spiochaetopterus SARS:—[1] WEBSTER, 1879

Type-species by original designation: *Spiochaetopterus typicus* SARS, 1856.

Definitions. As *Spiochaetopterus* — SARS 1853, p. 390; 1856, p. 7; WEBSTER 1879, p. 46; USHAKOV 1955, p. 265[2]; DAY 1967, p. 527. As *Telepsavus* — COSTA 1861, p. 53; FAUVEL 1927, p. 81; MONRO 1933, p. 1052. As *Leptochaetopterus* — BERKELEY 1927, p. 441.

Long, slender worms. Peristomium forming a semicircular collar around the ventral and lateral sides of the small, blunt prostomium. One pair of long, coiled and grooved palps. Anterior region of 9 (rarely 10) setigerous segments bearing unilobed notopodia. Setigers 7—9, which are usually longer than the preceding segments, have a conspicuous ventral gland marked on the 7th segment. Setiger 4 with a single (rarely 2) stout modified setae.

Middle region with a variable number of segments, bearing bilobed or trilobed notopodia, with fine embedded setae, and uncigerous neuropodia. Posterior region with several segments bearing finger-like unilobed notopodia with internal supporting setae, and uncigerous neuropodia. Tube chitinous, closely ringed, mostly clear, sometimes with an outer layer of fine grains; straight or twisted.

Remarks. SARS (1856), in his diagnosis of the genus, limited the segments of the middle region to two and also mede the absence of eyes a generic character, but these characteristics were removed when the genus was emended by WEBSTER (1879). COSTA (1861) established the genus *Telepsavus* which he distinguished as having its body divided into two regions instead of three.

Discovering the posterior (third) region of a *Telepsavus* sp., BERKELEY (1927) erected a new genus *Leptochaetopterus* which MONRO (1933) and most authors considered to be a synonym of *Telepsavus*. However, having their body divided into three regions, and in accordance with WEBSTER's definition, both genera are synonyms of *Spiochaetopterus*.

[1] For the use of dashed colon (:—) see discussion page 19.

[2] The page number refers to the 1965 translation.

Key to species

1. Prostomium knob-like, short or elongated 2
— Prostomium cleft and bilobed, with a pair of large eyes. Peristomium shovel-shaped. Middle region of about 10 segments ..... .*S. madeirensis*

2. Middle region of 2 segments. No eyes 3
— Middle region of about 20 segments or more, with trilobed notopodia and bilobed neuropodia. Frequently with a pair of eyes. Ventrum of setigers 6—7 with a dark gland usually preceding a light coloured gland on the following two segments ..... *S. costarum*

3. A fairly stout species, 2—5 mm wide. Peristomium horseshoe-shaped, short and fleshy. Prostomium ovoid. Ventrum of setigers 7—8 with a white shield-like gland, sometimes preceded by a dark arc. Middle region with fleshy parapodia ..... *S. typicus*
— A slender species, usually less than 1 mm wide. Peristomium shovel-shaped, elongated and thin. Prostomium elongated. Ventrum of setigers 6—8 with a brown to reddish gland. Middle region with foliaceous parapodia — trilobed notopodia and unilobed neuropodia ..... *S. bergensis*

Spiochaetopterus typicus SARS, 1856

Descriptions. As *Spiochaetopterus typicus* — SARS 1856, p. 1, pl. 1, figs. 8—21; USHAKOV 1955, p. 271[1], fig. 106.

A fairly large species, 100—130 mm long and 2—5 mm wide. Prostomium ovoid and without eyes, but with a pair of long palps. Peristomium horseshoe-shaped, short and fleshy (Fig. 1A). A mid-dorsal groove runs from the prostomium to the pygidium. Anterior region of 9 setigers. Setiger 4 with one stout modified seta accompanied by normal slender setae. Ventrum of setigers 7—8 with a conspicuous, white glandular shield, which may be preceded by a dark arc, or extended forwards as a darker coloured gland up to the 3rd setiger.

Middle region of 2 segments bearing a mid-dorsal cupule and thick fleshy parapodia. Notopodia bilobed or trilobed, with fine setae embedded in the inner lobe. Neuropodia bilobed (the first neuropodium sometimes unilobed), with uncini. Posterior region with numerous segments bearing unilobed, clavate notopodia and bilobed, uncigerous neuropodia. Tube straight or slightly twisted.

Type locality. Western Norway.

Distribution. Northern Atlantic, Arctic, North-west Pacific.

Remarks. I have examined several Norwegian specimens, a few of which were dredged from shallow waters, but most from deep water sediments consisting of fine sand, silt or clay. All specimens appeared to lack eyes and the middle region in each case was composed of 2 segments.

Spiochaetopterus madeirensis LANGERHANS, 1881

Description. As *Spiochaetopterus madeirensis* — LANGERHANS, 1881, p. 94, Pl. 4, fig. 6.

Prostomium cleft and bilobed, with a pair of large lateral eyes (Fig. 1B). Peri-

[1] The page and figure numbers refer to the 1965 translation.

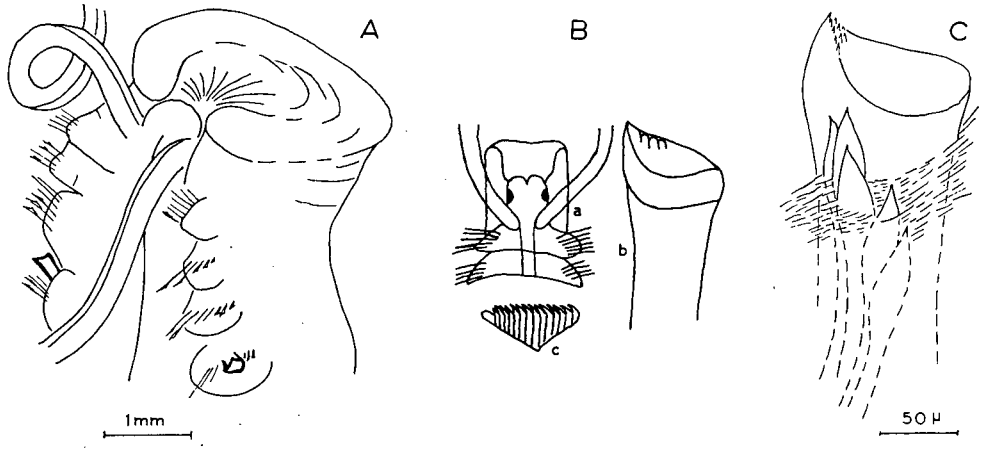

Fig. 1. A. *Spiochaeropterus typicus*, anterior end. B. *Spiochaetopterus madeirensis* (redrawing from LANGERHANS 1881; scale not known): a, dorsal view of anterior end; b, modified seta of setiger 4; c, uncinus. C. *Telepsavus bonhourei*, modified seta of setiger 4 with accompanying normal setae.

stomium shovel-shaped. One pair of palpi. Anterior region of 9 setigerous segments. Setiger 4 with a stout modified seta accompanied by mormal slender setae. Ventrum of setiger 7 with a dark gland.

Middle region of 9—10 segments bearing foliaceous scalloped notopodia and neuropodia with uncini. Posterior region with several segments. Tube transparent.

Type locality: Madeira.

Remarks. The species, which has not been completely described, is probably related to *S. costarum*. FAUVEL (1927) considered it to be a synonym of *S. typicus*. *S. madeirensis*, however, is distinguished by its cleft prostomium, the presence of eyes, and the far greater number of segments in the middle region.

Spiochaetopterus bergensis sp. n.

Description. A slender species, over 30 mm long and 0.5—1 mm wide (Fig. 2A). Prostomium blunt and elongated, without eyes. Peristomium shovel-shaped, thin and elongated. One pair of long palpi. Anterior region of 9 setigerous segments bearing unilobed notopodia with varied asymmetrical lanceolated setae (Fig. 2B). Setiger 4 with a modified seta (Fig. 2C) accompanied by normal setae. Ventrum of setigers 6—8 with a brown to reddish gland.

Middle region of 2 segments bearing laterally ciliated, trilobed foliaceous notopodia with 4—8 fine setae embedded in the inner lobe and unilobed uncigerous neuropodia (Fig. 2D). The notopodia of the second middle segment are a bit larger than the preceding ones.

Posterior region of about 17 segments or more, bearing unilobed, finger-like notopodia, each with 2—3 supporting hastate setae, the tips of which sometimes project from the bulb-like ends. The bilobed neuropodia consist of a small upper

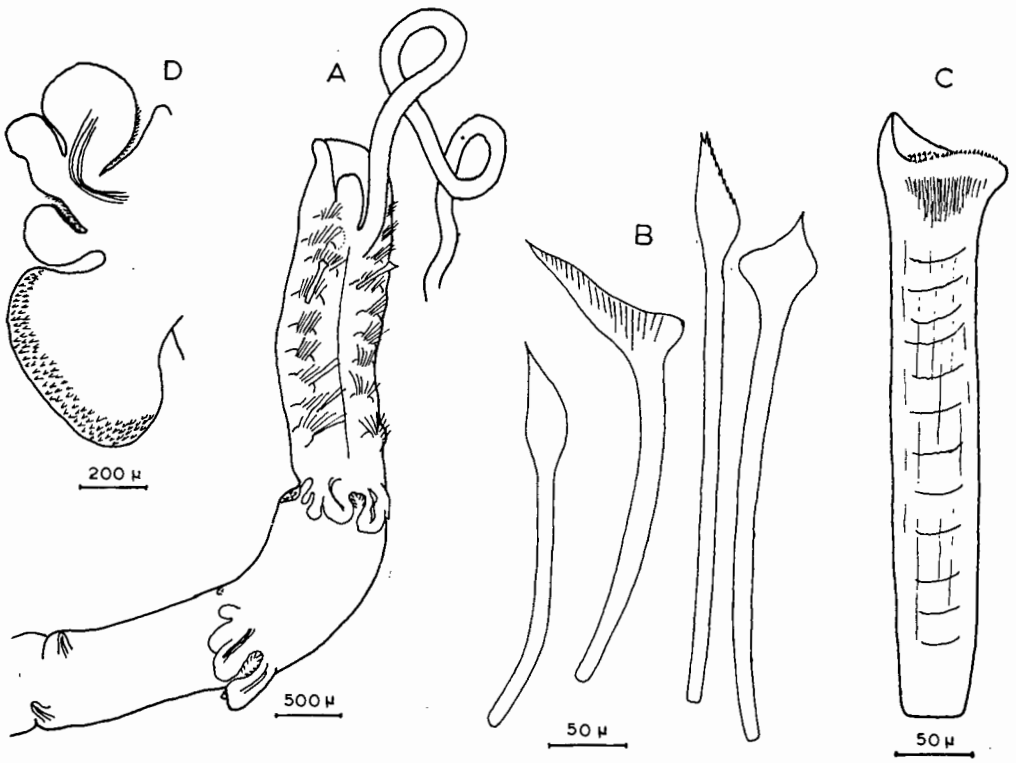

Fig. 2. *Spiochaetopterus bergensis* sp. n. A. Dorsal view of anterior and middle regions, and first segment of posterior region (the left palp has been omitted from the drawing). B. Lanceolate setae of anterior region. C. Modified seta of setiger 4. D. Parapodia from first segment of middle region.

lobe directed forward and a larger lobe directed backward (Fig. 3A). Both lobes have some bands of delicate uncini (Fig. 3B). Pygidium (Fig. 3C) with a fan-shaped, transparent extension.

Tubes twisted, semitransparent, sometimes with an outer layer of fine sand grains; they are about 70 mm long or more and have a diameter of 0.5—1 mm.

R e m a r k s . *S. bergensis* is distinguished by the arrangenemt of its neuropodia and the colour of the ventral gland; in addition, it differs from *S. typicus* in the shape of the buccal complex, the nature of the parapodia, and its size. It also differs from the other species of the genus in the number of segments in the middle region, the absence of eyes and the shape of the peristomium.

T y p e l o c a l i t y. Sörfjorden, east of Åkre, 60°15′35″N, 6°35′00″E, western Norway, abt. 400 m depth, fine sandy bottom (Biol. Station Reference No. Z 46–58).

M a t e r i a l. Holotype deposited in the Zoological Museum, Bergen, Catalogue No. 49, 348. Paratypes deposited in the same Museum, No. 49, 349. The remaining material is kept in the Biological Station, Univ. of Bergen; the British Museum (Nat. Hist.); the Smithsonian Institution, Washington; and the author's collection.

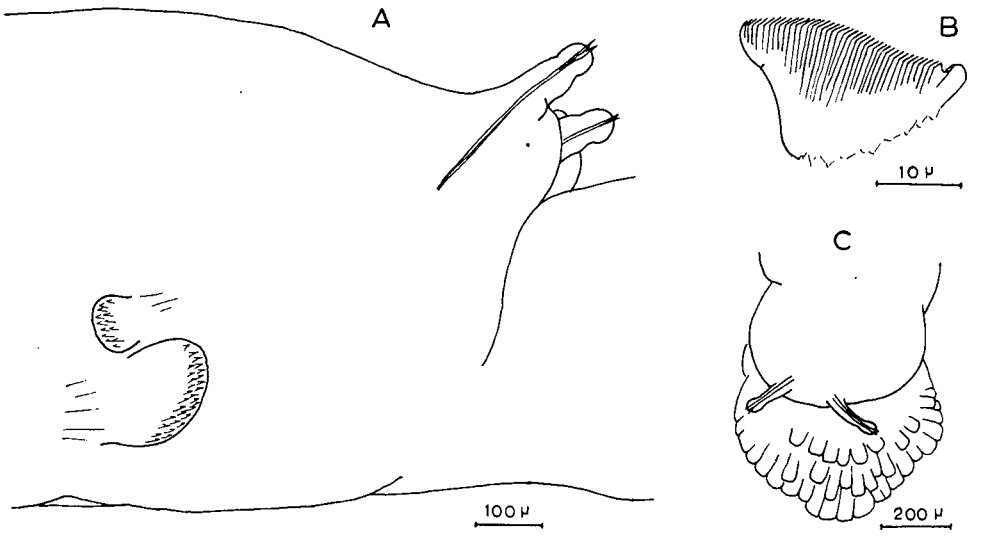

Fig. 3. *Spiochaetopterus bergensis* sp. n., posterior region. A. A segment with two unilobed notopodia and a bilobed neuropodium. B. Uncinus. C. Pygidium.

Spiochaetopterus costarum costarum (CLAPARÈDE, 1868)

Descriptions. As *Telepsavus costarum* — CLAPARÈDE 1868, p. 340, pl. 20, fig. 1; BARNES 1965, p. 218, figs. 1—3. As ?*Telepsavus bonhourei* — GRAVIER 1905, p. 93; 1906, p. 191, figs. 209—213. As *Telepsavus vitrarius* — EHLERS 1908, p. 114, pl. 15, figs. 1—8; KIRKEGAARD 1959, p. 29; DAY 1967, p. 528.

A slender species about 80 mm long and 1—1.5 mm wide. Prostomium ovoid with a pair of lateral eyes usually covered by a pair of long, grooved palps. Peristomium horseshoe-shaped, short and fleshy. A ciliated groove runs along the mid-dorsal line. Anterior region of 9 setigerous segments, the last three of which are usually longer than the others. Setiger 4 with one modified seta accompanied by normal setae. A dark ventral gland, most clearly marked on setiger 6 or 7, preceding a white gland on setigers 7 to 9.

Middle region of about 30 segments, bearing trilobed notopodia with a bundle of fine setae embedded in the inner lobe, and uncigerous, bilobed neuropodia. A mid-dorsal cupule on middle segment 2. Posterior region of a variable number of segments with finger-like, unilobed notopodia supported by a few hastate setae, and uncigerous, bilobed neuropodia. Tube horny, transparent, straight or slightly twisted.

Type locality. Naples.

Distribution. Mediterranean, Eastern Atlantic, Indian Ocean (?).

Remarks. I examined two Neapolitan specimens from the British Museum collection; both appeared to lack their hind parts, though in one of them I managed to recognise a few finger-like notopodia from the posterior region, which

have already been described by MONRO (1933). I also recognised the uncigerous neuropodia of this region, which appear to be bilobed and are almost identical with those described and figured above (Fig. 3A) for *S. bergensis*.

The fairly complete knowledge of the original species makes it possible to compare it with variants described from other geographical areas, as well as with related species which in my opinion should be considered as subspecies.

Examination of *Telepsavus vitrarius* specimens in the British Museum, the Copenhagen Zoological Museum, and the University of Cape Town, all collected in West African waters, has shown that the species is identical with *S. costarum costarum*. Both species have their 7th setiger marked with black and white ventral glands. These glands may appear in related species as well and thus are of limited taxonomic value.

I have also examined the type of *Telepsavus bonhourei* described by GRAVIER (1906) from Djibouti. There are two specimens in the Paris Museum; both lack their posterior regions and are almost identical with *S. costarum costarum*. In setiger 4 there were normal setae (Fig. 1C) which escaped GRAVIER's attention. Setigers 7 to 9 are noticeably longer than the preceding setigers but this is known to be the case in other species as well. One of the specimens bears two oblique grooves between the palps. These grooves might be caused by the position of the palps at the time of fixation and I doubt whether they represent specific nuchal organs. Since the posterior region of the species has not been found, however, it is impossible to be definite about its systematic position.

Spiochaetopterus costarum oculatus WEBSTER, 1879

Descriptions. As *Spiochaetopterus oculatus* — WEBSTER 1879, p. 47, pl. 8, figs. 98—102; BARNES 1964, p. 397, figs. 1—4.

Length 30—60 mm. Width 0.5—1.6 mm. Prostomium with a pair of lateral eyes. Peristomium horseshoe-shaped, short and fleshy. Two long, coiled, and grooved palps. Anterior region of 9 setigerous segments with fleshy notopodia. Setiger 4 with a modified seta accompanied by normal setae. Setigers 5—6 or 7 with a dark ventral gland, preceding a white or cream-coloured gland on the following two or three setigers.

Middle region of 18—37 (commonly 20—24) segments, with fleshy trilobed notopodia and bilobed neuropodia. Posterior region of 20 segments or more, bearing unilobed, clavate notopodia and bilobed neuropodia. Tube transparent, or occasionally opaque.

Type locality. Virginia.

Distribution. North-west Atlantic.

Remarks. I examined a few specimens from Massachusetts, U.S.A. The fleshy parapodia are a notable feature in which it resembles *S. typicus*; otherwise it is almost identical with *S. costarum costarum*. BARNES (1965), however, pointed

out that the main difference between the two species is in their feeding mechanism; while *S. costarum costarum* employs only a single mucus bag, eight or more bags are employed by *S. costarum oculatus*.

Spiochaetopterus costarum pottsi (E. BERKELEY, 1927)

Descriptions. As *Leptochaetopterus pottsi* — E. BERKELEY 1927, p. 441, figs. 1—3. As *Telepsavus costarum* — E. & C. BERKELEY 1952, p. 63, figs. 127—130.

A large subspecies, up to 480 mm long (when fixed) and 3 mm wide. Prostomium with a pair of large, lateral eyes. Peristomium horseshoe-shaped, short and fleshy. Two long palps. Anterior region of 9 segments with the normal arrangement of setae and ventral glands.

Middle region of 30—90 segments or more, with trilobed notopodia and bilobed neuropodia. Posterior region of numerous segments with unilobed, clavate notopodia and unilobed neuropodia.

Type locality. Nanaimo (British Columbia).

Distribution. Canadian Pacific region.

Remarks. This is probably the largest species in the genus since several living specimens were recorded as having lengths of up to 630 mm. Apart from its size, it is distinguished from *S. costarum costarum* by the undivided neuropodia of the posterior region.

Spiochaetopterus costarum var. *monroi* nov.

Description. As *Telepsavus costarum* — MONRO 1933, p. 1052, fig. 4.

MONRO (1933) wrote of this species: "Body divided into three regions, ... an anterior region of 9 chaetigers, a middle region consisting of a very variable number of segments (in the present specimens the number is about 50), and a posterior region. ... There is a single pair of tentacles. The prostomium is oval and eye-spots are indistinct. The mouth is terminal and the peristomium forms a collar round it open on the dorsal side. The anterior region, consisting of the first 9 chaetigers, is concave dorsally and convex ventrally.

The 7th, 8th, and 9th chaetigers are longer than the rest and are provided with conspicuous ventral gland-shields. The 4th foot has normal bristles in addition to the single chaeta. In the middle region the notopodia are divided into two ciliated lobes standing vertically in the back. There is also on each side an accessory branchial lobe. The neuropods are of the usual bilobed form and provided with rows of minute triangular uncini. In the hinder region the notopods (text-fig. ...) are not bilobed, but consist of single, elongated, cylindrical processes with expanded ends, and they enclose two or three delicate bristles. The neuropods appear to be single in the hinder region, and they are joined to the notopods by transverse glandular pads...".

Occurrence. Gorgona Island (Equatorial Eastern Pacific).

Remarks. It is clear from the above description that the subspecies is distinguished from *S. costarum costarum* by the undivided neuropodia of the posterior region and also by the absence of eyes, in which it differs from *S. costarum pottsi* as well.

Spiochaetopterus costarum var. *okudai* nov.

Description. As *Telepsavus costarum* — OKUDA 1935, p. 94, pl. 5, figs. d, e, text-figs. 6—8.

Length up to 180 mm or more. A small rounded prostomium without eyes. A pair of long palpi. Anterior region of 9—10 setigerous segments, each marked with two bands of brown spots, dorsal and ventral to the bases of the notopodia. Normal arrangement of setae and ventral glands.

Middle region of about 67 segments with trilobed notopodia. Posterior region of numerous segments with clavate, unilobed notopodia. All neuropodia, save the first one, bilobed.

Occurrence. Japan.

Remarks. The species differs from the related Eastern Pacific species by the divided neuropodia of the posterior region and the remarkable coloured spots. It is distinguished from *S. costarum costarum* by the absence of eyes and also by the far greater number of segments in the middle region.

Spiochaetopterus patagonicus KINBERG, 1867

Remarks. KINBERG's (1867) short description does not give sufficient information for a diagnosis of the species. The type specimen in the Stockholm Riksmuseum has decayed and only some setae of the anterior region are identifiable. The status of the species should thus remain in doubt until new material is described from the Patagonian area.

Spiochaetopterus tropicus GRUBE, 1877

Remarks. GRUBE's (1877) description casts doubt on whether the species is actually a *Spiochaetopterus*. The 12 setigerous segments of the anterior region are far too great a number for this genus. On the other hand, the pair of foliaceous organs, described as situated near the bases of the palps, may represent the tentacular cirri of a *Phyllochaetopterus*.

Spiochaetopterus herdmani HORNELL, 1903

According to WILLEY's (1905) description the species belongs to *Phyllochaetopterus*.

DISCUSSION

1. Most of the species studied are allopatric (MAYR et al. 1953), although it is not certain that any of them are reproductively isolated. In dealing with taxonomic discrimination between such taxa, one is bound to rely mostly on morphological differences, as the available material is still rather limited.

The following features represent the main differences between the species, subspecies and varieties of *Spiochaetopterus*:

1. Prostomium — ovoid and short; elongated or cleft.
2. Presence or absence of eyes.
3. Peristomium — horseshoe-shaped, short and fleshy; or shovel-shaped and delicate.
4. Width or length of grown specimens, if difference exceeds 100 per cent.
5. Number of middle region segments, if the difference exceeds 100 per cent.
6. Neuropodia of the middle region — unilobed or bilobed.
7. Neuropodia of the posterior region — unilobed or bilobed.
8. Appearance of parapodia — fleshy or foliaceous.
9. Shape of uncini.
10. Colour pattern.
11. Feeding mechanism — number of mucus bags employed.

The last two features may be of little use when dealing with preserved material. The same applies to all the setae of the anterior region, which were found to vary greatly and thus are of little taxonomic value.

A specimen distinguished by at least three of the first seven features listed above has been considered here as a separate species, while specimens "inhabiting a geographic subdivision of the range of the species" (MAYR 1963) and distinguished by any two of the above features, are considered to be of subspecific rank. A re-examination of the two Pacific varieties of *S. costarum* will probably reveal that both deserve subspecific rank.

2. Although application of the above rule may lead to the recognition of a greater number of valid species, it is desirable that similar criteria should be used for other genera as well, in order to provide a unified taxonomic method for each genus.

The most confusing genus in this respect is probably *Chaetopterus*, in which most authors recognise only a single species, *C. variopedatus*. Referring to this species, OKUDA (1935) described two Japanese varieties: Type A, from muddy bottoms, with a length of 180—200 mm, 23—25 modified setae, a posterior region of 47—57 segments with lateral neuropodia bearing two cirri, and a characteristic U-shaped tube with foreign material on the outer surface. Type B, from coral masses, with a length of 20—30 mm, 4—11 modified setae, a posterior region of 13—16 segments with lateral neuropodia bearing only one cirrus, and an irregular U-shaped tube devoid of foreign material.

If OKUDA is right in his assumption that "these features may probably be derived from their environment" and that both types are only varieties of *C. variopedatus*, then there is hardly room for more than one species within *Spiochaetopterus*, or in any other Chaetopterid genus.

3. Since their erection, many genera have been emended, so that their present diagnoses differ considerably from the original ones. However, according to ordinary practice, the generic name itself, as well as the name of its original author, is not affected by the emendation. Thus, in citing a generic name it is not always clear which diagnosis is being referred to. In order to clear up this confusion, it is suggested that the name of the subsequent user of a generic name shall be cited, together with the emendation year, following a dashed colon (:—) between the two names. Such a practice would be in accordance with the recommendation of Article 51 of the International Code of Zoological Nomenclature (1964).

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A REVIEW OF *AUGENERIELLA* (POLYCHAETA: SABELLIDAE) AND A NEW SPECIES FROM NORTHERN SINAI

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A REVIEW OF *AUGENERIELLA* (POLYCHAETA: SABELLIDAE) AND A NEW SPECIES FROM NORTHERN SINAI

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ABSTRACT

Augeneriella lagunari sp.n., from the Bardawil lagoon, is distinguished by repeated dichotomous branching of the ventral filaments on the branchial lobes. A review of the known species of *Augeneriella* reveals that the branched ventral filaments are the most characteristic feature of the genus, thus arguing the exclusion of *A. dubia* from the genus.

GENUS *AUGENERIELLA* BANSE (CHAR. EMEND.)

Augeneriella was erected by Banse (1957) for a minute new species, *A. hummelincki*, from a saline lagoon in the West Indies. The only other members of the genus that have been described are a subspecies, *A. hummelincki indica* Banse (1959), from southern India, and a doubtful species, *A. dubia* Hartmann-Schröder (1965), from Hawaii. The genus, which is closely related to *Fabricia* Blainville as defined by Hartman (1951), is distinguished from all other genera of the Fabriciinae by the possession of a pair of branched ventral filaments on the branchial lobes. These characteristic filaments are distinctly developed in the eastern Mediterranean species described below.

Augeneriella lagunari sp. nov.

MATERIAL: The species is known from many preserved specimens and the type-series consists of eight adults and five juveniles. Holotype and paratypes, Reference No. II AN 133, are deposited in the Department of Zoology of the Hebrew University of Jerusalem. The remaining material is kept in the U.S. National Museum (USNM 42727), the University of Cape Town and the Hebrew University of Jerusalem.

TYPE LOCALITY: Bardawil lagoon, Mediterranean coast of Sinai, in shallow hypersaline water.

DESCRIPTION: The maximum thoracic width of the holotype is 0.43 mm and the total length is 3.6 mm, of which the branchial crown makes up to 0.5 mm or about 1/7 of the length. A deep dorsal groove runs along the thorax.

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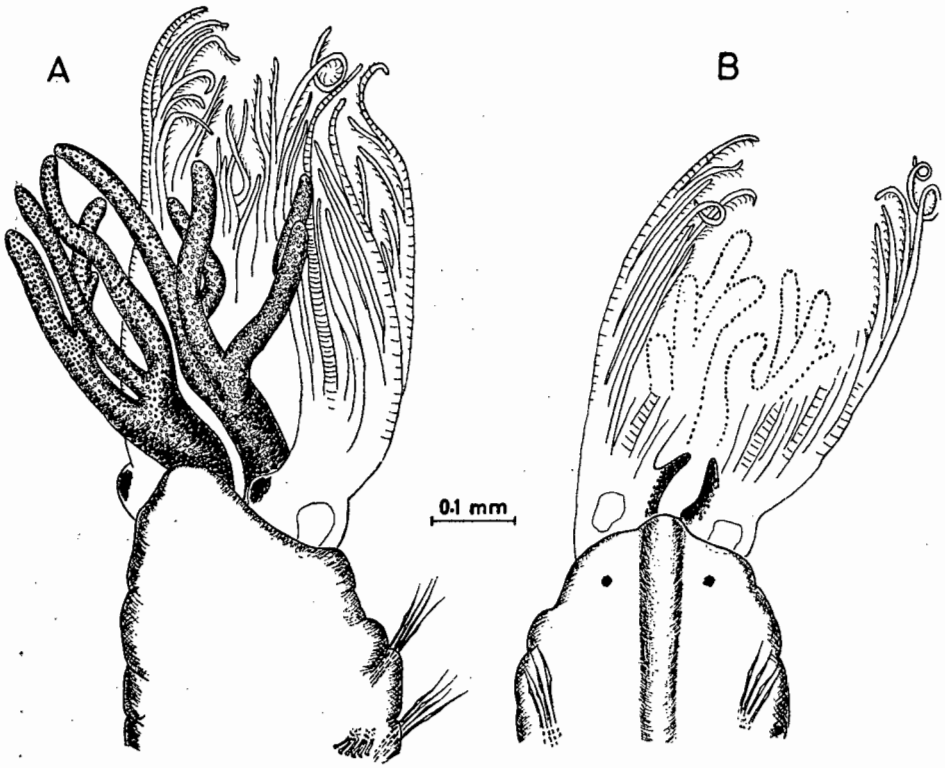

Fig. 1. *Augeneriella lagunari* sp. nov., anterior end. A. Ventral view. B. Dorsal view.

The branchial crown (Fig. 1A) consists of 2 lobes each having 3 radioles, a pair of ventral filaments each having 2–3 successive dichotomous ramifications, and a pair of pigmented and dorsally situated medial "lips" (Fig. 1B). In the base of each lobe there is a branchial heart. In most of the specimens large pigment spots are located on the ventral bases of the lobes.

Each radiole has 5–7 pairs of pinnules partially covered with cilia. The pinnules branch from the inner side of the radiole in 2 rows and their tips do not end at the same level. The ventral filaments are 1/2 to 3/4 the length of the radioles. Their surfaces are irregular, non-ciliated, and they may be heavily pigmented, especially on the lower trunk. There is a ventral, forward projecting peristomial "collar" and, on the dorsal surface, a much smaller blunt projection. The latter is formed by the end of the dorsal groove, which terminates near the "lips". Two dark eye spots are located inside the collar segment on either side of the dorsal groove.

The thorax is composed of 8 setigerous segments, the first of which lacks neuropodial hooks. Each bundle of notosetae consists of 4–6 winged capillaries up to 0.25 mm in length (Fig. 2A). In setigers 3–7, some of the inferior winged

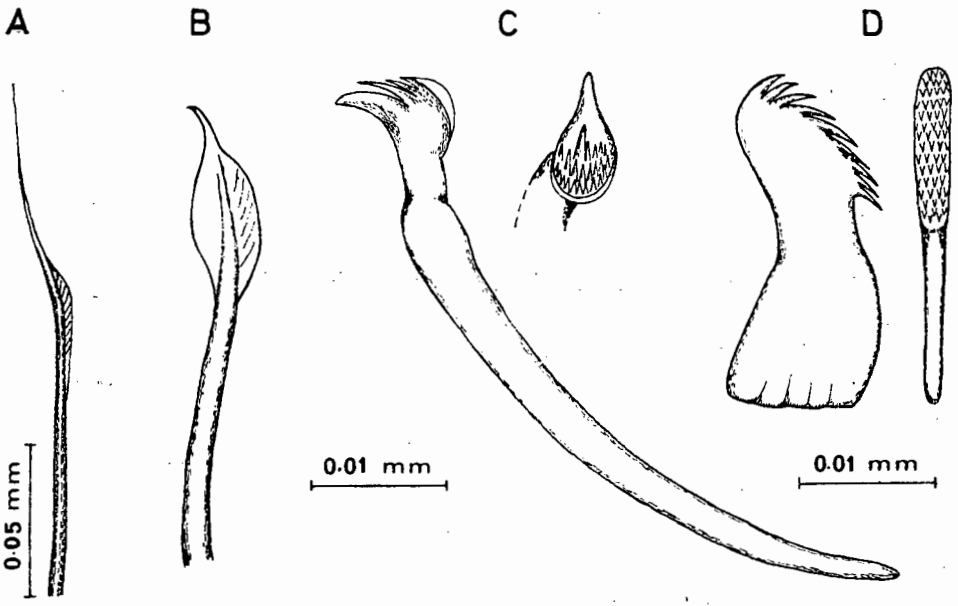

Fig. 2. *Augeneriella lagunari* sp. nov. Bristles. Thoracic: A. Winged capillary. B. Subspatulate seta. C. Hook, profile and edge-on view of distal end. Abdominal: D. Profile and edge-on view of uncinus.

capillaries are replaced by shorter subspatulate setae (Fig. 2B). Toward setiger 8, the latter become intermediate in shape and appear more like winged capillaries. Each thoracic neuropodium has a row of 5–10 hooks. The hooks are about 0.05 mm long, each possessing a strong tooth above the main fang, surmounted by a crown of smaller teeth in 2–3 semicircular rows and capped with a crescentic hood (Fig. 2C).

The abdomen possesses 3 segments, each with 3–4 simple capillaries 0.15–0.20 mm long, and a row of 15–30 uncini decreasing in number towards the last segment. The uncini range from 0.013 to 0.025 mm in length and each uncinus has a broad compressed manubrium and about 15 rows of teeth, with 3–5 teeth in each row. However, only 9 teeth could be seen in profile (Fig. 2D). The pygidium possesses a pair of dark eye spots.

In juveniles, the setae are small and few in number and the ventral filaments are partly developed and poorly branched. Pigment spots are also lacking on the lobes. One of the adult specimens has non-branched, short and thick filaments which are believed to have been deformed through injury.

The tubes are coated with a thick layer of fine particles.

REMARKS: *A. lagunari* is distinguished by the repeated dichotomous branching of the ventral filaments. Of secondary importance is the relatively short branchial crown, which is only 1/7–1/6 of the body length. This compares with the ratio

of 1/4–1/3 in *A. hummelincki hummelincki* and *A. hummelincki indica.* In addition the new species differs from the other members of the genus by not having the pinnules ending at the same level, which calls for the emendation of the original generic definition.

A REVIEW OF CERTAIN DIAGNOSTIC CHARACTERS OF *AUGENERIELLA*

Examination of type material kindly sent by Dr. Gesa Hartmann-Schröder of the Hamburg Zoological Museum, reveals that the abdominal uncini of *A. hummelincki hummelincki, A. dubia* and *A. lagunari* all have similar shapes when viewed in true profile (Fig. 2D). Also, each thoracic hook of *A. hummelincki hummelincki* possesses the same main fang, strong tooth, crown of small teeth in 2–3 semicircular rows, and crescentic hood as described for *A. lagunari* (Fig. 2C). Apart from the delicate hood, which might have been overlooked, similar thoracic hooks were described for *A. hummelincki indica.* Unfortunately, this subspecies has not been examined by the author.

The thoracic hooks of *A. dubia* do not possess a crescentic hood nor is there a strong tooth above the main fang. Instead, the crown of each hook consists of many rows of small, closely packed teeth. Since this species also lacks branched ventral filaments and typical subspatulate thoracic setae, I support Hartmann-Schröder's (1965) reservations regarding its inclusion in *Augeneriella.*

The ventral filaments of *A. hummelincki hummelincki, A. dubia* and *A. lagunari* all have a similar wrinkled surface, but no blood-containing structure could be discerned in the ventral filaments of any specimen. On the other hand, the morphological structure of these filaments is clearly different in each species. Unlike *A. lagunari* (Fig. 1A), the two subspecies of *A. hummelincki* have bifurcated filaments, while *A. dubia* has simple non-branched filaments which are similar to those described and figured for *Fabricia limnicola* (Hartman, 1951).

As previously stated, the blood cavity in the ventral filament is not a clear morphological feature and often difficult to distinguish. Therefore, to avoid confusion with closely related genera, it is suggested that the definition of *Augeneriella* should be emended to include only species of the Fabriciinae with branched ventral filaments.

Emended generic diagnosis

Fabriciinae a few mm long with 7–15 setigers. Each branchial lobe with 3 free radioles bearing pinnules, and a branched, non-ciliated, ventral filament. Thorax with notopodial winged capillaries, usually with subspatulate setae among them; neuropodia with long-shafted hooks. Abdominal uncini with a broad compressed manubrium, which is usually longer than the distal toothed edge.

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MARINE FARMING PROSPECTS ON THE SOUTH AFRICAN WEST COAST

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Introduction

THE high primary production caused by the Benguela current and the intensive upwelling along the western coast of South Africa provides this country with one of the world's richest fishing grounds. But here, as in many other places, the exploitation of these resources is often abused, resulting in a relatively low global output supplying only 1 per cent of the food utilized by man.

Most of the efforts to achieve a higher maritime production are invested in the improvement of fishing methods. However, intensifying the fishing activities, sometimes through sophisticated mechanisation, often results in overfishing which is especially acute in coastal regions. To restore the balance of nature, conservation measures which regulate fishing seasons, minimum fish size and maximum quotas ought to be introduced, but these in turn restrict the activity of the fishing industry, causing unemployment among its labour force and seriously affecting its profits.

Nevertheless, even if the balance of nature is restored and restrictions are modified, exploitation of the sea through fishing only remains a short-sighted policy. With the ever-increasing demand for proteins, fishing, like hunting, is unable to satisfy this need.

Since in conventional fishing a relatively high link in the food chain is being harvested, only 1/1 000 — 1/10 000 of the organic material primarily produced by the first link, i.e., phytoplankton and seaweed, may be harvested by man (Gilmartin, 1969). Thus, if through using techniques of marine farming we manage to produce a given amount of protein from lower or fewer food links we increase the very production of the sea and consequently its total output.

Problems and Realities of Marine Farming

Unfortunately, whenever the subject of marine farming is considered by the local business community it is treated, in the main, with scepticism. It should be noted, however, that in Japan, Australia, Canada, U.K., France, Spain and even Italy, where primary production is much inferior to that in South Africa, marine farming is a profitable enterprise.

Assuming that the risk involved in investing in this emerging industry is not greater than in the traditional fishing industry, the main difference between these two is that in the latter the operational responsibility lies with the skipper, whereas in marine farming this role is taken over by the scientist.

When selecting species for cultivation, not only their commercial importance and the expense involved in their production should be considered. Knowledge of their biology, the availability of larvae, the rearing methods and the breeding techniques — if the natural supply of larvae is unreliable — must be acquired.

Taking all these factors into account it will be shown that the integrated cultivation of black mussels, rock lobsters and, in certain areas, abalone, is a feasible proposition for establishing marine farms along the western coast of this country.

Artificial Breeding of Black Mussels

The black sea mussel *Mytilus edulis* is an important marine resource of the Northern Hemisphere which, in Europe alone, has a yearly output of over ¼ million tons (Davies, 1969). Most of this output comes from marine farms in which the spat are collected from the sea and the rearing is done on poles or ropes hanging from rafts.

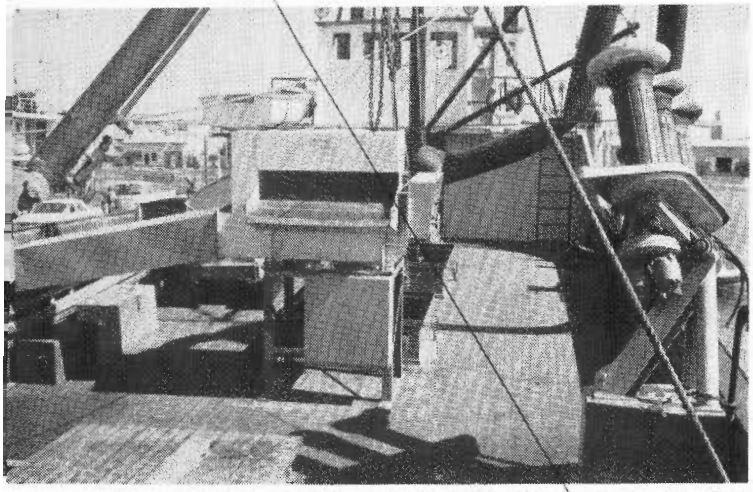
Being a fast-growing plankton feeder, the mussel efficiently converts its food into a tasty, high quality protein (Field, 1922). The wholesale price of imported European mussel is about 40 cents per pound.

The edible Mytilidae family is abundantly represented on the western coast of South Africa by *Choromytilus meridionalis*, which is indeed being collected for human consumption, and by *Aulacomya magellanica*. Having a smooth shell, *C. meridionalis* resembles *M. edulis* closely, although on protected rock and sandy shores it may reach a greater size, up to 13 cm. The smaller, ribbed and brownish *A. magellanica* occupies rocky regions, mainly below the tidal zone, where it densely covers vast areas.

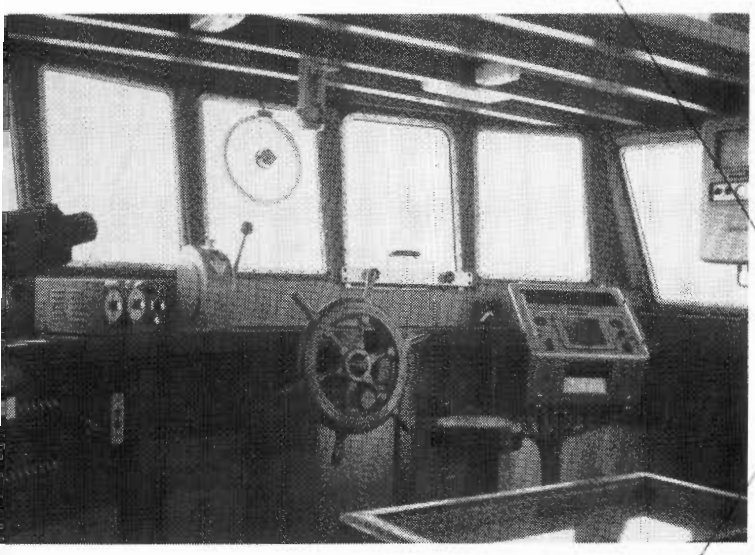
Both species are eagerly preyed upon by starfish and rock lobsters, but neither of the mussels is commercially exploited.

As is practised elsewhere, the spat of the local mussels could be collected from the open sea, but taking into account the great variability of species and the peculiar climatic conditions here, difficulties in obtaining spat may be expected. This problem, however, could be overcome by breeding the spat artificially.

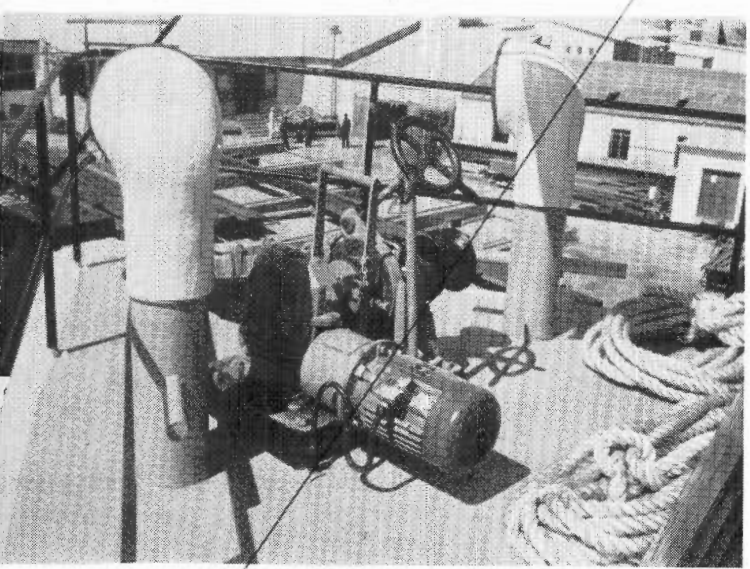
In a series of experiments carried out at the University of Cape Town, the author was able to induce the spawning of *C. meridionalis* and to breed the larvae up to the settling stage. This was accomplished only after overcoming the difficulty of supplying the larvae with the proper food. Using bacteriological techniques, selected species of local phytoplankton were isolated and cultured for feeding purposes (Fig. 1). Since feeding is the crucial problem in any artificial breeding, it is to be expected that with the ability to produce a large variety of local food



The apparently small dewatering plant, mounted aft of the hatches, has adequate capacity. The duct from the plant runs over the top of the rail, not through the bulwarks in the usual way.



Interior of the spacious wheel house from the port bulkhead. The table at right partly covers the companion from the main deck level mess and there is an access to the whale back deck to the right of the picture.



Petrel windlass is powered by an electric motor. The hawse tube runs through the stem post. The ventilation ducts to the fo'c'sle crew's quarters also serve as bollards.

ing, when the high transom rail is replaced by a fixed transom roller and the starboard net guard is removed. The addition of fuel and water tanks and other alterations from purse seining to trawling were described in our October, 1971 issue.

A major improvement on the *Delta* is the hydraulically operated engine room ventilation fan. On the *Gamma* it was mounted for'ard of the small after deck house which serves as access for the engine room and contains the engine exhaust ducts. On the *Delta* the fan forms an integral part of the deck house and is protected in such a way that water cannot be drawn in.

The deck house is set close to the port rail with access on the inboard side. (Access is on the outboard side of the *Gamma's* deck house).

The main engine is an MTU type MA 12V 362 TA60 which develops 740 hp at 1 500 rpm. The gearbox is a Lohmann and Stolterfoht with a 4 : 1 reduction driving a Hundested variable pitch propeller. This equipment was supplied by Industrial Machinery Supplies. On the front pto of the main engine is mounted a Funk disengageable triple gearbox which feeds power to three Dynapower hydraulic pumps which power the winch, Triplex and net stacker. The DECT 634/16 hydrostatic drive system was supplied and installed by Hytec.

The auxiliary engine is a Bedford producing 52 shp at 2 200 rpm. It drives a Stamford 25 KVA 380 volt 3 phase alternator, a compressor, bilge pump and an hydraulic pump for the ventilation fan.

The auxiliary engine and the main engine gearbox are cooled by water circulating through a keel cooler on one side of the vessel. The main engine is cooled via a keel cooler on the other side.

The manual/hydraulic engine and gearbox controls were supplied and installed by Hytec. The variable pitch control employs Morse control cables.

The 380 volt electrical system is supplemented by a 24 volt emergency system and is fitted with a transformer/rectifier for reducing the high voltage to 24 volts DC for the electronic equipment. Supply and installation was by R. Kratz of Luderitz.

A striking feature of the *Delta* is the heavy timbers used in the construction of the hull. An exceptionally sturdy design and construction was vital since the vessel was expected to carry heavy loads in all weather conditions without having to reduce speed.

The keel is of Kari measuring 18 in. by 14 in. in cross section, the keelson and sister keelson also of Kari measuring 12 in. by 9 in. The Iroko double frames are 4 in. wide and 9 in. high at the hog and $6\frac{1}{2}$ in. at the deck. The planking is partly Iroko and partly Oregon, all 3 in. thick. Deck beams are of Kari and Oregon measuring 10 in. by 6 in.

When the *Delta* entered the water the keel for the next 92 ft. vessel from the Nieswandt yard was being laid down. This vessel may be offered for sale outside the Consortium group.

sources, successful breeding of other commercial species can now be achieved.

When a fully ripe female is induced to spawn, a few million eggs are discharged and nearly all of them are fertilized in the water. Given an optimal temperature and sufficient space, a large proportion of the larvae can be brought to settle on spat collectors within two months. Afterwards, the collectors could be transferred from the nursing laboratory to the natural environment. By rearing the mussels on ropes or in net bags which are hung from rafts protected from rough seas, cultivation could be easily controlled and the danger of predation minimized.

Since conditioning of *C. meridionalis* for out-of-season spawning has been proved possible, this will enable rational planning of production to be made according to economic considerations. Field observation in the Cape Town area show that a marketable size of 6–7 cm could be reached within 13–15 months and that in the following years a length of about 1 cm per year is added.

The present market for mussels is mainly in Europe but a great potential lies in the Asiatic market. The local market, on the other hand, should be developed carefully to gain the confidence of the public. As mussels may remain poisonous for a few months after being exposed to a "red tide" and since they are easily spoiled through careless treatment, it would be advisable to supply the market with only quality-controlled tinned or pickled products.

Since a great surplus of mussels could be expected, only a small proportion of the cultivated stock would be selected for marketing. All the rest will be used for feeding rock lobsters which would be catered for in the surrounding area.

Cultivation of Rock Lobsters

The rock lobster *Jasus lalandii* is a very important South African marine resource which is at present under strict control. A slow grower, it takes about 7 years to reach maturity or a marketable size, but, according to Matthews (1962), this growth rate could be influenced by the availability of food.

According to Heydorn (1969) the main food of *J. lalandii* is the black mussel *A. magellanica* which occupies the same environment. Even though the mussels were in great abundance, the lobsters were observed to select only those which were isolated and easily removed from their anchorage. These eating habits resemble those of a scavenger and indeed, *J. lalandii* is mainly looking for easily obtainable food.

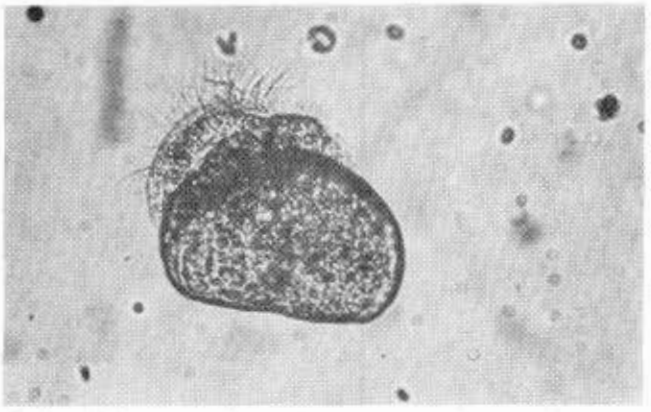


Fig. 1: A black mussel larva feeding on a culture of flagellates. Actual size of the larva is 0,15 mm. On the Cape West coast, this mussel would attain a marketable size within one year.

In spite of being a gregarious species, during its foraging the rock lobster is able to migrate a few miles. Other reasons for migration are shelter seeking during the moulting and berry seasons and inshore migration due to occasional drop of oxygen content in the bottom water (Newman & Pollock, 1971).

Taking into account their eating habits and their gregarious nature, the rock lobsters not only could be made to grow faster by artificially supplying them with suitable food, but they may be expected to cease any notable migration if a selected natural environment is always baited with their favourite food.

Other possible methods of cultivating rock lobsters may include rearing them in outdoor tanks. These tanks should be supplied with shelter-providing objects such as fragmented tyres and should contain water at a higher temperature than the sea. Under these conditions the lobsters can be expected to accelerate their growth rate to a great extent. Similar effects of higher temperature were noted by the author while experimenting on the growth rate of local marine larvae, and have been proved elsewhere with regard to several fish, shellfish and prawns.

Apart from accelerated growth, specimens reared in warm water sometimes exhibit a precocious maturity, a decrease of adult size and a shortening of the life cycle (Naylor, 1965). Since the adverse biological effects are of secondary importance, from the commercial point of view, this method may have far-reaching applications.

For experimental use, pre-settling puerulus larvae may be collected from the sea by illuminated traps, but, for large scale rearing, other sources should be considered, including artificial breeding which has been proved possible with the American lobster.

The prerequisites for establishing an integrated marine farm are a concession over a suitable farming area and a nursing laboratory. The laboratory should contain a cold or airconditioned room with circulating sea water, but a source of pumped sea water would increase its versatility. The nursing laboratory could also be used to breed other commercial species, such as abalone, which can be reared in the same farming area without affecting the other cultivated species.

Abalone Breeding and Further Prospects

Feeding on seaweed, the abalone produces primary protein which is of high quality and is in great demand in the Far East. Abalone breeding is an established technique and in Japan it is being practised on a commercial scale. Since experiments

carried out by the author show that the local species, *Haliotis midae*, can be induced to spawn, there is little doubt that it can also be bred.

The biology of *H. midae* has been extensively studied and according to Newman (1969) the largest specimens were collected between Cape Point and St. Helena Bay where their food is in great abundance. In this region, however, the productivity of the abalone is not at its optimum because of low spawning intensity and slow growth caused by the low average temperature.

These problems can be overcome to a great extent by artificial breeding and by rearing the juveniles in the warmer surface water by rafts. The use of rafts for cultivating abalone in net-protected containers is practised in Japan (Professor Uno, personal communication).

As marine farming progresses, the introduction of other species such as flatfish, the brackish water dwellers of the Mugilidae fish family, scallops and prawns should be considered. This would include the increasing use of coastal ponds which will have the advantage of possessing a more favourable temperature, greater control over the cultivated specimens and of not being restricted to a particular location. In addition, the use of heated water effluent from power stations should also be considered in this context.

Conclusions

The high primary production along the western coast of South Africa provides a natural resource which is considerably underexploited. At present, only the "hunting-economy" of fishing is being practised, which is subject to considerable fluctuations unrelated to the huge productivity of the area. In order to avoid further abuse of this resource, it is necessary to introduce the scientifically based techniques of marine farming.

With the present knowledge of marine biology, integrated cultivation of black mussels and rock lobsters could be introduced as a first stage. Further stages will include culturing abalone and other commercial species, introducing techniques of accelerating the growth rate, and employing outdoor tanks and coastal ponds. If these ideas are proved right — and there is no way to prove it other than by trying — the fishing industry could substantially increase its output.

As in any other investment there is a risk involved, but taking into consideration the present shortcoming of our fishing industry, the possible employment of idle labour and the success of marine farming elsewhere, this risk is worth taking. Even if there are set-backs, the experience gained will bring benefit to the fishing industry as a whole. Therefore, the pioneering investors should get the maximum assistance with concession rights, technical and scientific information as well as favourably termed loans.

Finally, it should be kept in mind that, unlike most other resources, the production of the sea is on a permanent cycle. Thus, for each year in which this resource is not exploited properly a national loss of revenue will occur.

Acknowledgements

Thanks are due to Mr. G. G. Newman of the Division of Sea Fisheries, Sea Point, for his encouragement and valuable comments; to Professor A. C. Brown, U.C.T. Department of Zoology, and Mr. D. L. Cram, the Division of Sea Fisheries, for kindly reading the manuscript; and finally to Professor Y. Uno, Tokyo University of Fisheries, for his advice on breeding techniques.

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GOOD CATCHES

ANCHOVY finally made its appearance off the Cape West coast at the end of April and large hauls were being made as we went to press. Quality was poor, the fish quickly disintegrating in the holds and yielding only one gallon of oil per ton or less.

The appearance of anchovy follows the highest pilchard landings on the West Coast for the first three months of the season since 1968 at 55 658 short tons and the highest mackerel landings since 1967 at nearly 50 000 tons.

Walvis Bay boats have been unable to find anchovy in any quantity, but massive hauls of large maasbanker were made within two hours of the jetties at the end of April. Because of its maturity, it is unlikely that the species originated from the same resource of immature maasbanker that boosted landings unexpectedly last year. By early this month, the shoals were breaking up and were moving south of Walvis Bay.

Pilchard landings have remained constant, being restricted by quota. The shoals have been found within two or three hours of Walvis Bay and the fish are large and in good condition.

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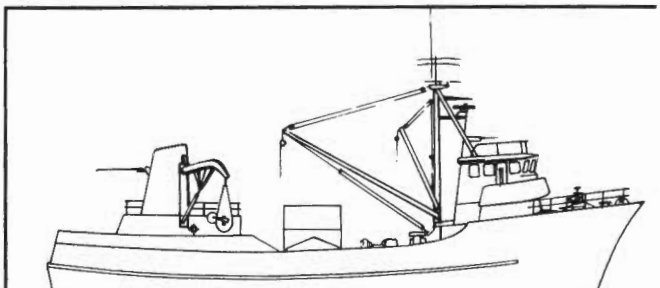

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Top illustration:
"Atlantic Pride", *heavy-duty pelagic fishing vessel owned by Willem Barends Built by Louw and Halvorsen. Service speed 11½ knots from 565 continuous h.p. CAT D379 engine.*

Bottom illustration:
"Aranos", *100 ft purse seiner owned by Suid Kunene. Built by Dorman Long Swan Hunter. Powered by CAT D398B turbo-charged and aftercooled diesel producing 850 c.h.p.*

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